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THE BARE FALLOW.

Elsewhere we make some extracts from the 1913 and 1914 Annual Reports of the Rothamsted Experiment Station which have recently been received at Peradeniya. At this institution a staff of twenty-five specialists is engaged upon "the study of the soil conditions that affect the growth of the plant and the nature of the changes induced in the plant by variations in soil and nutrition conditions," problems that cover the whole range of soil management and crop production. One lesson these reports convey is the importance of continuity. Though many of the experiments have been going on for 60 and 70 years, yet year after year light is thrown by them on new problems of agriculture.

A great deal of study is given to the behaviour of nitrogen, the most expensive ingredient the planter has to supply in his manures. It is well known that nitrogen compounds, whether in the soil or applied in manures, are attacked by micro-organisms which liberate the nitrogen to form soluble nitrates that can be taken up by the plant and gaseous nitrogen which, as far as is known, cannot. It was found that the rate of accumulation was rapid in the spring with the spring showers and rise of temperature, fell in the dry weather of summer, rose again with the renewed rain of autumn while the soil was still warm, and fell again in winter.

The stock of nitrates at the end of a hot dry summer is high, but this stock is very much increased if a summer fallow has been taken. When bare fallow follows a green manure we get a combination equal in results to heavy manuring. This was shown by an experiment made at Rothamsted in 1913. A field of lucerne of four years stand that had received no manure for some years was selected. This was ploughed up, fallowed during the summer and sown with wheat in the autumn. The resulting crop was greater than that of any plot receiving artificial manures and equal to that of the plot dressed with 14 tons of farmyard manure. It will be observed that the wheat crop was sown at the end of the summer and before the winter rains set in. Had no crop been growing to arrest the escape of the nitrates, much of the good effect of the summer fallow following the lucerne ley would have been lost. If instead of wheat a green manure crop had been grown, the nitrates would still have been taken up but returned again with interest when the green crop was ploughed in. Thus the sequence is green manure, fallow, green manure ; the fallow being taken in the dry weather.

We may gather from these conditions some useful ideas about the management of land in the tropics, especially in those places with a long dry season. The circumstances are complicated because in such countries the acute problem is generally the supply of moisture but happily the treatment that tends to promote the accumulation of nitrates—the summer fallow—tends also to conserve the moisture of the soil. The important point is that the land should not be left fallowed during the rainy season, but a crop planted to preserve the nitrates from being washed away in the rain water.

In the management of land in such a country as our so-called dry zone, which has a rainfall of some 50 inches per annum but a long dry season during which however a little rain falls from time to time, green manures should be used with judgment. At Rothamsted it has been found that the best results are only attained when a period of fallow comes after the green crop. As between a bare fallow and a green crop in the dry season the arguments are strongly in favour of the

former and these arguments are strengthened with us by the necessity we are under to check the dissipating action of the sun upon the slender reserves of water at the disposal of the plant ; which can be done by a properly worked fallow. In a young coconut plantation in the dry zone a green manure crop such as cow pea or gram that comes off the land in a few months and permits of the soil being worked through the dry season would be preferable to a perennial like tephrosia that would continue on through the dry season to evaporate moisture, thus counteracting much of the benefit it would otherwise confer upon the young trees. As the palms grew and spread their roots the value of the green crop would decline ; green manuring would in most cases eventually become impracticable ; but as the demands of the trees increased the bare fallow or its plantation equivalent would gain in importance.

R. N. L.

THE SWEET ARECANUT.

The authors in describing the species *Areca catechu* L. in the FLORA OF BRITISH INDIA, Vol. v, page 406, do not mention the astringent taste of the seed. The ordinary betel nut has a very astringent taste when tasted raw (before boiling), the amount of tannin and glucosides being over 14 per cent. (Lewin. uber *Areca catechu*, etc.). The present variety is fairly sweet to eat and is further distinguished by the fact that the endosperm is much lighter in colour and softer. On account of the latter character, it becomes pulpy and does not lend itself to the treatment which the areca-nut undergoes before being sent to the market. The cultivators find it a loss to propagate these plants, and it only grows occasionally in the areca gardens. The plant bears the same type of fruit year after year and has to be ranked as a distinct variety. I propose the name var. *delicciosa* on account of its pleasant taste.

Areca catechu L. var. *delicciosa :* tree 40 to 80 feet high with leaves and flowers similar to those of *Areca catechu*, fruit slightly smaller about 1 inch in diameter, remaining green even when nearly ripe, endosperm pale white in colour, soft when ripe, percentage of tannin much less.

Distribution.—Occasionally met with in the areca gardens in the Western Ghats of Mysore.—M. K. VENKATA RAU in the JOURNAL OF THE BOMBAY NATURAL HISTORY SOCIETY.

POTASH.

REVIEW OF THE PRESENT POSITION.

Potash is one of the essential elements of plant-food and is found universally in soils. Potassium, the element, is found in combination with silica, etc., in many rocks and occurs to the extent of 2·4% as potash in the crust of the earth and is the chief source of potash in soils. Potassium silicates are difficult to decompose and are insoluble in strong acids but by weathering they gradually break down into less stable and more soluble compounds from which the plants derive their supply of potash. Potassium compounds, principally chlorides, are found in small quantities in sea-water, about 0·5—0·7 per 1,000, probably all obtained originally from the leaching by rain of decomposed rocks. It is also found as the soluble nitrate in Peru, Chile, India, etc., but the big source of potash is the natural Stassfurst deposits in Germany and it is curious that no other large deposit of potash has yet been discovered. No other element is so uniquely isolated in deposition in quantity as potassium and at the same time so universally scattered over the earth in small quantity, and for this reason a description of the formation of the Stassfurst deposits is interesting.

THE STASSFURST DEPOSITS.

Theories as to the formation of the huge potash deposits more or less agree, but they do not explain everything and much is still left to the imagination. It has been stated above that potash is present in small quantity in sea-water, and it is from this basis that Germany has derived her potash beds. It can be traced geologically that the sea had at one time extended over large areas of Germany and then gradually receded by geological changes in the level of land and sea leaving a number of inland seas and lagoons, some of these connected with the sea by means of small estuaries. At this time tropical conditions existed over the northern part of Europe as proved by fossils of tropical plants and animals. The tropical sun evaporated and concentrated the waters of the inland lakes until the concentration became so great that the waters became saturated with some of the less soluble salts in solution, and they gradually crystallised out. The concentration continuing, the saturation point of more soluble salts was reached and they crystallised out. The waters then became saturated with still more soluble salts and they in turn reached their crystallisation point. The inland seas which were connected with the ocean were continually obtaining additional sea-water through their estuaries while the concentration process was going on, making the process continuous and giving rise to great beds of salts, crystallised out according to their solubility, the less soluble crystallising out first. The weak point in this theory is the high percentage of potash salts compared with other salts present, and must point either to sea-water exceptionally rich in potash or else the strata on which the evaporation took place to be exceptionally rich in potash. The temperature required to evaporate such great quantities of sea-water must have been high for the time taken, higher than one would expect under tropical conditions, an explanation of which might be given by the action of

subterranean heat, or the heat given out by the interaction of the salts in solution. Examination of the Stassfurst potash beds will find the less soluble salts at the bottom of the beds. Calcium sulphate forming the bottom layer, then comes a 3,000 ft. bed of common salts which took about 13,000 years to deposit. This mass is interspersed with layers of calcium sulphate, showing that this salt had again accumulated in the lakes probably due to further influx by the sea, and had again reached a saturation point and crystallised out. These layers of anhydrite become fewer as the top layers of salt are reached, and their place is taken by a more soluble saltcalled "polyhalite," a mixture of the sulphates of lime, potash, and magnesia. This area is called the "polyhalite" region and is succeeded by the kieserite region in which the sulphate of magnesia predominates. Above this comes a deposit 30 to 130 ft. thick, which is the most important from the potash point of view, as from this layer nearly all the agricultural potash is prepared. It is called the "carnallite" region and is composed of muriate of potash and muriate of magnesia, and overlying these deposits is a layer of clay which acts as a water-proof protector to the soluble salts below. Above this impervious layer comes more anhydrite and a very pure deposit of common salt: again gypsum, clay, sand, and then outcrops of limestone are found on the surface. The total depth of these beds is little less than a mile and they extend over the whole of North Germany. It must not be supposed that on examination of the Stassfurst deposits parallel layers of salts are to be found, due to the internal pressure over geological ages these layers have become displaced and in some cases tilted up and exposed to atmospheric influences, and rain speedily dissolved out the salts, and on other conditions presenting themselves favourable to concentration recrystallised out again in different combinations.

The deposition of the potash beds has been further explained by USIGLIO who experimented on the evaporation of sea-water and found that the Stassfurst deposits were not quite in agreement with the mere evaporation of sea-water and came to the conclusion that there must have been less of mother liquor at periods and autumnal influx of fresh sea-water, rain and floods, thus diminishing the extent of the more soluble salts and giving an increase of the less soluble salts. The anhydrite (calcium sulphate) layers mark a certain periodicity in the deposition of the salts which quite bears out the above observations. Surprise is expressed by many that the calcium sulphate crystallised out as anhydrite, without water of crystallisation, and not as gypsum with two molecules of water of crystallisation, but it has been proved that a nearly-saturated solution of common salt dehydrates calcium sulphate forming anhydrite on crystallisation. The clay layer was probably due to an eruption and saved the lower layers from leaching but lost the mother liquor salts to the deposits, and explains to a certain extent why the composition of evaporated sea-water differs from that of the Stassfurst deposits. Where the protecting layer of clay is absent drainage and leaching dissolved the top layers, and accounts for the difference in this case. At present there are similar deposits of salts now being formed in Europe in parts of the Caspian Sea and the Sarmatian Lakes.

The German potash deposits were first used as a source of common salt, but were abandoned in 1839 as a salt source for a purer deposit of common salt and more economical working. The old brine deposits were not absolutely abandoned but were explored by boring, with astonishment to

the explorers, at the depth of the deposits obtained, but as the percentage of potash and magnesia increased in the brines the deposits were looked upon with disfavour as it interfered with the crystallising of the common salt. Further investigation showed that these deposits could be used as a source of potash and the common salt was then looked upon with disfavour as it interfered with the purification of the potash. The year 1860 marks the new era for the salt deposits in Germany, for it is from that time that they were used as a source of potash chiefly for agricultural purposes, and the extraction from the deposits has gone on by leaps and bounds since then.

The Board of Trade states that the sales of the German potash syndicate in the year 1914 amounted to £78,000,000 as compared with £96,000,000 in 1913. The estimate for 1914 was £105,000,000. Working expenses have gone up and there are skilled labour difficulties. These drawbacks with the cessation of exports due to the war will minimise the profits of the syndicate considerably. Representations are at present being made to the German Government to reduce the price of potash to local agriculturists so as to enable them to purchase largely and obtain huge yields by its application.

Local agriculturists use the unpurified deposits, getting it at a cheap rate but when the salts have to be carried any distance the freight makes the salts very expensive, so they are made into muriate of potash with 58 % potash, and sulphate of potash, with 50-52 % of potash. Kainit also has a large sale with 13 % of potash. Where the chlorine is not desirable, as for tobacco cultivation, the sulphate of potash is used or the potassium magnesium carbonate with 17-18 % potash, which is also manufactured at the Stassfurst mines. Pre-war days these salts were extensively used all over the cultivated world and were practically the only sources of potash applied as a manure at least in bulk. No manufacture of potash could in any way compete with these vast deposits of easily accessible and readily convertible potash salts, as the bases of supply from ashes, etc., is not localised sufficiently to manufacture into concentrated salts which could stand freight to far countries.

Natural deposits of potash have been searched for by prospectors in every land but with practically no success. Occasionally one hears of promising deposits of salts, but generally the economic conditions are not favourable. Great hopes are still expressed that natural deposits may be found, and the war, which has stopped exports of Germany's potash salts, has stimulated the search and researches on waste products and cheap material from which to manufacture concentrated potash salts. The war has reduced agriculture to potash starvation and to the same stage as it was as regards potash at the middle of the nineteenth century, but at that period there was not the same demand for potash as the manufacture of artificial manures had not reached the height it has to-day, and there was not the same stimulus to agriculture giving huge crops at home and abroad. Again the tropical belt was still undeveloped.

OLD AND NEW SOURCES OF POTASH.

The sources of potash supply fifty or sixty years ago are now being reinvestigated as a source of potash for to-day. Seaweed is washed up in many lands on many shores and is again coming to the front as a source of potash. Many farmers near to the coast plough seaweed into their land but farmers at a distance from the coast have not the advantage of a ready

supply of organic matter with valuable mineral matter, and these men require the kelp, the ash of the sea-weed, to be made into a more suitable and concentrated form for transport. In those days kelp was used as a source of iodine and potash salts, but the industry was killed by the working of the Stassfurst deposits, and the iodine is now obtained from the Chile nitre beds where it occurs as sodium iodate. According to MERZ and LINDEMUTH (J. Ind. Eng. Chem.) the ash of the Macrocystis amounts to 2·5-3·5%. Muriate of potash 16-30 %, Iodine 0·1 %, nitrogen 1 %. Dry kelp contains 19·8 % potash.

Potashes made from the ashes of wood were at one time the largest bases of source of supply of potash salts, but as wood went out of use as a fuel, being displaced by oil, petrol and coal, ashes became scarce. Whole forests were burned up for the sake of potashes and if the utility of the Stassfurst deposit had not been discovered there would have been great wastage in fuel in obtaining ashes. Some forests are badly situated as a timber source and all woods are not suitable for timber, so that these might have been used up for the manufacture of potashes, but generally the nearest forests are taken for such purposes. The potash in wood-ash exists as carbonates to a great extent, but in the grasses as silicates. Wood ashes also contain phosphates and lime giving useful additional value to the potashes. The harder the wood the more potash it generally contains. The soft pines contain less potash than the hard oak. Herbs contain more than shrubs, shrubs more than trees. Different parts of a tree contain different proportions of potash; generally the growing points and young leaves contain most, and the bark is usually richer than the wood. Seeds are also rich in potash, the hull being generally richer than the interior. When oil seeds are used as a source for oil they are crushed for the oil and the residue or poonac used as a manure or feeding stuff. The potash is a valuable addition to the nitrogen on which the cake is valued as a manure. Phosphoric acid is also present in about the same quantity as potash in seeds, usually about 1-2 % in the poonac. This mounts up when large quantities of poonac are used per acre.

UMNEY in the PERFUMY. and ESSENT. OIL RECORD suggests co-operation in collection and utilisation of waste marine and land plants. Some of the potash results are given below:—

Fucus serratus	4—5 %	Agaricus velutipes	78 %
,, nodosus	13 %	Heath Mosses, Hypund schreberi	28–30 %
Laminaria saccharina (oarweed)	15 %	Hop bine	25 %
Zosteria marnia	9·5 %	Groundsel, Senecio vulgaris	43·5 %
Bracken	60 %	Common broom	33 %
Bœetus edulis	50–57 %	Willow Bark	24 %
Tweel chestnut Bark	20 %	Common furze	28 %
Euphorbia amycyldaloides	39 %	Virginia creeper leaves	25 %

RUSSELL in the JOURNAL OF THE BOARD OF AGRICULTURE suggests obtaining potashes from the hedge clippings, etc., and experimented with green and dead wood, grasses, weeds from hedges and ditches, by burning them in the open, 10·9 % of potash was obtained. Refuse material from threshing floors yielded an ash containing 11 % potash. The potash is present as

carbonate, and after exposing to rain lost half of its potash. The ashes obtained from trimming of 100 yards of hedge weigh about 15 lb. and cost about 8 pence. The ashes are very light, and mix well with superphosphate but have not the same keeping properties as kainit. But the ashes of these would only interest the farmer who made the potashes from these for his own use, and are hardly interesting from an industrial point of view. They are of no interest to the tropics.

The United States still produce 10—15,000 tons of potashes which is entirely consumed locally. According to the CHEM-ZEIT potashes are manufactured from the stems of sun flowers in 24 factories in North Causasia to the extent of 100,000—120,000 tons per annum.

ROMANIS in the CHEMICAL NEWS states that potash is made from bamboo-cane in British Burmah.

The ash contains

Potash	...	...	32·5
Muriate of potash	...	...	18·7
Silica	...	...	17·0
Carbonic acid	...	...	8·1
Sulphate	...	...	2·7
Iron and alumina	...	...	1·1
Moisture	...	...	19·4

In the process of green manuring the green manure plant draws its potash from the soil generally at some depth and when cut down returns the potash to the soil in the form of potash salts of organic acids. If the attempt were made to form potashes from the organic refuse by burning, large quantities of organic matter and nitrogen would be dissipated and considerable value lost to the soil. The same is true of tea-prunings, which contain about 25 % of potash in the ash.

It is a well-known fact that before a plant sheds a member a large proportion of the important constituents are returned to the main part of the plant so that some of the fertilizing material is retained by the plant, but the part which falls to the ground by the plant shedding a member is not to be despised.

Cocoa leaves are very rich in potash when they are young but as they get older silica largely takes its place, so that when they are shed the potash has been largely transferred to the younger or growing parts of the plant; but the potash retained, although small, is valuable and should be utilised by mulching.

Refuse from coconut plantations is rich in potash as the coconut tree is a greedy potash feeder. Coconut husk is rich in potash, 2·5 % when dried, and should always be utilised by ploughing in between the rows or placing as a mulch round the trees with a covering of soil; the potash in the husks will soon be absorbed by the roots by this procedure. Coconut shells will not decay so readily, but as they contain 0·5 % potash they have some value as a source of potash. The ash from coconut shells prepared when using the shells as a fuel when making copra is useful as a ready source of potash and should be spread round the neighbouring trees.

Tobacco is a greedy feeder of potash and hence the refuse is a source of potash. The mid-ribs, stalks, etc., which are not used for manufacture of tobacco should be ground up, extracted with water, and the solution which contains nicotine sprayed on plants as an insecticide while the residue could be used as a manure. Tobacco is very rich in ash, containing about 15 %, of which 50 % is pure potash.

Sugar beet is another greedy feeder of potash, and in order to obtain the potash from the residues, the molasses, which is the residue after getting all the crystallisable sugar out of the juice, is fermented with yeast, the alcohol distilled off and the residue sprinkled on the soil for the sake of the potash it contains, and thus preserving the nitrates which are present in valuable quantity. Molasses contains 44-50 % of sugar, 14-18 % of other organic matter, 16-18 % of moisture, 10-12 % of ash. If the molasses is burnt in the air, Vinasse cinder, as it is called, is prepared and the valuable nitrates are lost. Germany has treated molasses in a special way by osmosis, strontia and lime process. Another method followed on the Continent is to carbonise the material in a retort getting as bye-products from the distillate, trimethylamine, methyl chloride, methyl alcohol, ammonia, etc., the cinder being left in the retort. The cinder contains :—

Potash	...	...	49·5
Soda	...	...	2·5
Lime	...	...	5·0
Carbon di-oxide	...	...	26·0
Phos : acid	...	...	0·3

So it is a valuable source of potash.

Another base for procuring potash if it were run on properly organised lines is the refuse from wool washings. The sheep gives off a peculiar substance called "suint" which is really sheep's sweat, and is collected in the sheep's wool : before the wool can be used it must be cleansed from this impurity and if the dirt were retained and worked up a valuable source of potash would be obtained along with other bye-products such as fats, but generally the waste is allowed to run on to the fields for fertilising purposes and in many cases runs to waste. A central washing station is the most desirable method of collecting the washings, but manufacturers prefer that they wash their own wool, then knowing that the wool they purchased goes to their factory. Under these conditions the manufacturer does not consider it economical to collect the refuse. As 100 parts of wool gives 14-18 % salts or five parts potassium carbonate, 60,000 tons of wool imported could give 3,000 tons potassium carbonate if the scheme were thoroughly organised. None is recovered. On the Continent 2,000 tons per annum is obtained. There is a difference in the composition of the 'suint' of inland and seashore sheep: in the former the soda is 2·2 % while in the latter the soda is 13 %. Suint gives 79 % potassium carbonate, 9 % potassium sulphate and chlorides.

Where vines flourish and wine is made a residue called "argol" is obtained, which is crude potassium bitartrate and when ignited potassium carbonate is formed, which can be used as a potash manure; or the argol is purified and exported as potassium bitartrate.

The nitre beds mentioned above exists in Chile, Peru, and in parts of India. The conditions for the formation of these beds is nitrogenous organic

matter, air, and potash to absorb the nitric acid formed by the bacterial process. The district must be very dry, else the nitrate formed soon gets dissolved out. The original source of potash is usually felspar, which is very common in rock formation and although insoluble when fresh, weathers to a form in which it can be attacked. The nitre forms in an incrustation on the surface of the soil and is scraped off and purified by solution from the insoluble matter and crystallisation from other soluble salts.

It would be interesting to note here that during the French Wars the French government ran short of nitrate of potash to manufacture black powder, which was the propellant in those days. The scientific department devised a means similar to the above to make the nitrate. Heaps of rubbish such as garbage, stale urine, mortar, etc., were made with a steep end facing the prevailing winds. Nitrification was rapid under those conditions ; nitrate of lime was quickly formed sand extracted and nitrate of potash by double decomposition with ashes was made from it.

ROCKS.

In the fore part it was noted that where the soil is uncultivated the plant derives its potash originally from rocks. On examination of rocks it is generally found that there is more than one class of crystal and on microscopic examination the different crystals are easily recognised. The commonest potash bearing crystals orthoclase and mica are distinctive and their decomposition is seen, felspar always having a muddy appearance showing the starting of the decomposition into clay. On a laboratory scale the decomposition of felspar has been studied and the complex silicate has been found to decompose into clay—an aluminium silicate—and potash. The latter is taken up by plants and the clayey matter is left. Mica decomposes in a similar manner, freeing the potash for the plant. The process by which rocks decompose due to natural agencies is called " weathering," and when the rock masses have been sufficiently disintegrated by natural means the mineral constituents pass into and form a portion of the soil. When these soils are analysed the potash which has been freed by decomposition and is ready for absorption by plants is called the available potash. Minerals which have not been decomposed sufficiently to dissolve in moderately strong acids are not estimated, for although potash is still there it is not available to the plant in a reasonable time. In cultivated soils the weathering process is hastened by drainage, forking, liming and green manuring; forking and draining expose the mineral particles to the action of the atmosphere; liming, by double decomposition, interchanges lime for potash freeing the potash in an available form for the plant ; while green manure obtains the potash from decomposed minerals from the subsoil and when mulched gives potash in a readily available form to the surface soil so that in spite of potash starvation due to the war agriculturists can to a certain extent do without this year's application by extra cultivation, especially if the soil is naturally rich in potash and has been regularly manured with potash in the past. This is borne out by the Cocoa Experiments at Gangaroowa, where no manuring has taken place for two years and yet the crops are still on the increase.

Soils which have mica present are generally well supplied with available potash. This is contrary to what others have found, micaceous soils generally being considered poor soils, but this probably refers more to temperate climates where the weathering is not so favourable to the decomposition of mica.

Attempts and many suggestions have been made to bring the potash in potash-bearing rocks into an available form suitable for agricultural purposes. Potash minerals are universally distributed but are so scattered that great expense would be incurred in collecting them for treatment, and greater expense incurred in the treatment. On referring to the analysis of the common potash-bearing strata, the low percentage of potash is noted.

	Potash	*Oxide of Alumina*	*Silica*
Orthoclase	10·9%	18·4%	64·7%
Leucite	21·5 ,,	23·5 ,,	55·0 ,,
Muscovite Mica	11·3 ,,	38·5 ,,	45·2 ,, 4·5% *Water*

Orthoclase and mica are the most common of above ; so that it will be seen that large quantities require to be collected before one could obtain a few tons of potash salts equivalent in quality to Stassfurst sulphate of potash : and the insoluble nature of the silicates means that either a high temperature must be obtained to fuse the mineral, after fine grinding with fluxes or lime, or else fluorides and strong sulphuric acid added to break up the silicate. It can be done easily in the laboratory but not economically in the factory, but still attempts have been made. One of these products which came under the writer's notice was called "phonolith" and was apparently one of the silicates treated so as to render part of the potash soluble. The analysis is given below:—

Phonolith

Moisture ...	3·7 ...	3·7
Loss on Ignition ...	5.07 ...	5·07
Insoluble in Hydrochloric acid, chiefly silicates	59·65 ...	59·65
Silica	50·12	
Iron and alumina oxide ...	6·38	
Lime	0·26	
Magnesia	0·39	
Potash, insoluble in Hydrochloric acid	2·50	
Iron and alumina oxide ...	...	23·15
Lime	...	1·40
Magnesia	...	0·47
Potash soluble in Hydrochloric acid	...	4·50
Soluble silica	..	2·06
Total potash	...	7·00
Available potash ...	...	4·50

"Phonolith" was not favourably reported on by me and was never on sale in the Island, although it was experimented with in Europe but with varying results. It is easily seen that even although one was to get a huge deposit of leucite conveniently situated for manufacture and make it partly soluble it could never compete against the highly concentrated Stassfurst potash with 95 per cent. purity, as the insoluble silicates left would kill it as regards freight.

Hopes are expressed that when the Germans are driven out of Upper Alsace the salt deposits which cover an area of 200 square kilometres near Mülhausen will be thoroughly investigated and yield a good outturn of potash salts and so relieve the situation. Unfortunately they are deeply seated, 15/2000 ft., which means working at a high temperature.

AMERICAN DEPOSITS.

America has hopes in the Searles Lake deposits in California, which are estimated to contain potassium compounds equivalent to six million tons of chloride. Over a quarter of a million sterling has been spent on development but much more will be required before it is a commercial success. America's great hope is in the kelp beds for producing potash in commercial quantities, and a few ten thousand tons might be obtained from beet refuse, scourings of wool and wood ashes. The unfortunate part about America's bases of sources is that they are nearly all situated on the west coast and required on the east for agricultural operations. The great Appalachian felspar dyke is near the scene of agricultural activity, and might be used as a base for operations, but as the felspar contains only 10% potash considerable working up would be required before it could compete with the European product. America imports annually £3,000,000 worth of potash salts, the bulk being used for fertilisers and the balance for other industries such as the manufacture of carbonate, chlorate, bichromate, caustic potash, etc. It can be well understood from these figures why America, which has large agricultural industries and a large population to feed, is so anxious to be independent of Europe and its strife for its potash supplies. Germany at present is not exporting potash to America for fear she uses the salts in making explosives and sells them to her enemies.

Alunite, a potash alumina sulphate, is fairly widely distributed on all the western coast of the United States of America and when the sulphates are separated can be used as a concentrated potash salt with high fertilising value. Raw and ignited alunite contains 10·14% potash.

Potash has been recently found in Spain near Coldona about 40 miles North-West of Barcelona. The salts existing there consist of potassium sulphate and carbonate and are reported to be of great depth, beginning at about 200 ft. below the surface.

It will be seen after reviewing all the possible sources of potash that there is no practical way of obtaining large quantities of potash as obtained in pre-war days, but the agricultural world can rest assured that Germany will be only too glad to part with her potash when peace is declared in order to help to pay off the huge debts involved by the war. It would be a good score to seize the mines as part of the indemnity so that there could be no question of a monopoly, as Germany talks of a monopoly of nitrogen as she has been badly hit by the Chile nitre being declared contraband, and is thereby unable to procure easily the base of the manufacture of nitric acid which is required to make nitro-cellulose and nitro-glycerin, the basis of smokeless powder. But it is said that Germany has risen to the occasion by obtaining nitric acid indirectly from the air and it is to be believed, as OSTWALD had patents out for procuring it from nitrolim before the war and no doubt stress of circumstances has led to many improvements in the process.

THE IMMEDIATE THING TO DO.

Agriculturists who have indulged in high cultivation in the past can do without potash for the next three years by using up the manure residues so wisely invested in the past. The money usually spent on potash can be spent on extra cultivation and by applying larger supplies of nitrogen and phosphoric acid ; when potash is obtainable larger quantities than usual should be

applied, so as to obtain a good reserve and the quantities of nitrogen and phosphoric acid can be reduced. Indian nitrate can to a certain extent replace some of the German potash, but as it is combined with a readily available form of nitrogen it must be used with due caution, else a forcing action is obtained. When used, a reduction in other readily available and organic nitrogen should be made.

One amongst many things the war has taught us is that it does not do to depend on one country for anything. Dyes and potash salts are a case in point. The manufacture of dyes is now being attended to by the nation and it is hoped still further efforts will be made to relieve the world of the German potash monopoly. Who knows what legacy geological ages have left us, if we but search and find? The reward will be great for the prospector who is lucky to strike potash in quantity, and he will be a benefactor to the nation as it will mean a great national asset, cheaper sources of potash for agriculture, meaning cheaper food stuffs, potash for industrial operations and potash for export to compete against Germany and strike a blow at one of Germany's great commercial assets. Considering the area of the British Empire and the different climatic conditions under which it exists, there is probably more chance of potash deposits being found under the British Government than under other Governments.

Tables showing the proportion of ash and potash in various tropical plants.

	Ash	*Potash*	
Acacia diabetes	3·2 %	13·8 %	on ash
,, decurrens twigs ...	5·3 ,,	0·8 ,,	on dried sample
,, young melanoxylon ...	2·3 ,,	0·56 ,,	,, ,,
Adhatoda vesica	2·16 ,,	20·1 ,,	on ash
Albizzia molluccana	5·6 ,,	1·16 ,,	on dried sample
,, prunings	4·4 ,,	22·8 ,,	on ash
Artemisia Vulgaris (Worm Wood)	7·1 ,,	37·8 ,,	,,
Bodi plant (Psoralea corylifolia)...	9·28 ,,	22·18 ,,	,,
Cardamom leaves	7·2 ,,	20·2 ,,	,,
,, stem	3·3 ,,	13·3 ,,	,,
,, fruit	7·7 ,,	31·7 ,,	,,
Cashew nuts	— ,,	0·64 ,,	on sample
Castillo leaves	14·24 ,,	13·10 ,,	on ash
,, twigs	4·86 ,,	24·3 ,,	,,
Castor seeds	3·2 ,,	0·5 ,,	dried sample
Cocoa young red leaves and twigs	7·5 ,,	40·1 ,,	on ash
,, young leaves and twigs ...	7·2 ,,	39·7 ,,	,,
,, older twigs	5·3 ,,	29·1 ,,	,,
,, twigs fully developed ...	8·1 ,,	9·2 ,,	,,
,, leaves young developed ...	7·8 ,,	19·2 ,,	,,
,, ,, fully developed ...	11·5 ,,	6·6 ,,	,,
,, ,, fallen	13·1 ,,	1·2 ,,	,,
Coconut husk (dry)	5·3 ,,	47·0 ,,	,,
,, Shell	1·3 ,,	26·5 ,,	,,
,, Pinnæ mid-rib ... fallen	2·2 ,,	2·9 ,,	,,
,, Pinnæ ... fallen	10·9 ,,	1·1 ,,	,,
,, Leaf mid-rib ... fallen	3·2 ,,	0·6 ,,	,,

	Ash		*Potash*	
Citronella Grass	6·3	%	1·0	,, on dried sample
Crotalaria incana	9·6	,,	2·4	,, ,, ,,
,, laburnifolia ...	6·2	,,	1·81	,, ,, ,,
,, juncea	4·0	,,	14·1	,, on ash
Dadap leaves	7·4	,,	1·0	,, on dried sample
,, ,, fallen	8·6	,,	0·56	,, ,, ,,
Fern	—		29·00	,, on ash
Erthyrina lithosperma ...	7·3	,,	35·1	,, ,,
Ground nuts (whole) ...	3·8	,,	0·8	,, on sample
,, ,, fresh	1·7	,,	0·58	,, ,,
,, ,, fruits	10·0	,,	2·9	,, ,,
Hevea bark	10·6	,,	9·2	,, on ash
,, leaves	4·4	,,	25·8	,, ,,
,, ,, old	4·4	,,	4·7	,, ,,
,, wood	6·0	,,	13·5	,, ,,
,, seed husk	1·6	,,	0·31	,, on sample
,, ,, meal	3·4	,,	—	,, ,,
,, latex	0·35	,,	43·0	,, on ash
,, crepe	0·4	,,	23·4	,, ,,
,, biscuit	0·4	,,	26·4	,, ,,
Indian corn	—	,,	0·33	,, on sample
Congayam grass	10·7	,,	13·4	,, ,, ash
Kepitiya leaves	9·1	,,	0·65	,, ,, sample
Leucana glauca	6·5	,,	25·1	,, ,, ash
Lemon grass	9·5	,,	3·0	,, ,, sample
,, ,, fresh	2·02	,,	0·65	,, ,, ,,
Marsilia	13·1	,,	2·6	,, ,, ,,
Micania scandens	7·6	,,	42·8	,, ,, ash
Neem Husk	13·6	,,	0·75	,, ,, sample
,, Poonac	9·0	,,	1·69	,, ,, ,,
Passiflora fœtida				
,, roots and woody stems	3·64	,,	15·24	,, ,, ash
,, leaves, tendrils, fruits	10·06	,,	13·84	,, ,, ,,
,, green stems ...	3·8	,,	20·84	,, ,, ,,
Psorolea corylifolia	9·28	,,	22·18	,, ,, ,,
Phaseolus lunatus	7·7	,,	30·1	,, ,, ,,
Pithicolobium saman	5·0	,,	1·27	,, ,, sample
Sesbania aculeata	6·2	,,	15·6	,, ,, ash
Sophora glauca dry	5·5	,,	24·1	,, ,, ,,
Suriya tree	10·3	,,	26·8	,, ,, ,,
Sunflower	—	,,	2·0	,, ,, sample
Tephrosia candida	5·2	,,	31·6	,, ,, ash
,, hookeriana ...	4·4	,,	29·0	,, ,, ,,
,, purpurea	5·9	,,	24·0	,, ,, ,,
Tobacco	16·0	,,	25·9	,, ,, ,,
Vigna catjang dried	14·2	,,	3·46	,, ,, sample
,, ,, fresh	3·03	,,	0·73	,, ,, ,,
Tapioca stem	4·7	,,	22·1	,, ,, ash
,, leaves	8·6	,,	14·6	,, ,, ,,

These figures are estimated on the sun-dried material.

A. BRUCE.

COCONUTS.

CASSAVA AS A CATCH CROP WITH COCONUTS.

In his recently issued book, The Coconut, Professor E. B. Copeland, Dean of the College of Agriculture in the Philippines, discusses very impartially the question of catch crops in coconut cultivation. He argues that any catch crop must take something from the fertility of the soil, and that this by itself is bad for the coconuts. On the other hand coconut growing is a business, and the planter will prefer to grow another crop with the coconuts if thereby he can secure a greater profit. If labour conditions permit it will be found that under any reasonably good market conditions, there are various crops which can be taken from the ground and made to pay some profit above the cost of raising them and purchasing manures more than sufficient to replace what they take from the soil, and "that their culture will keep the coconut plantation in better condition than can be expected if attention is devoted to the coconuts alone."

Professor Copeland insists that catch crops will prove unprofitable in the long run, even if they give immediate returns, unless manuring is practised ; but, "if such a return is made, and in full measure, the coconuts will fare better for the operation : because the food of the catch crop is taken from the area between the coconuts, and the fertilizers can be applied more immediately by the neighbourhood of the young trees. And this is bound to result in their growing more rapidly than they would if they had all the ground to themselves, but were not helped to reach their food."

He then discusses the labour question and what should be done if catch crops are not employed ; and instances a case in which as the result of keeping the ground cultivated, trees six years old were six inches more in diameter than those in a control plot, kept clean weeded, but without the ground being worked.

The conclusion the author draws is, "This is indeed a very striking result, and it may prove, as the trees produce, that the money spent in cultivation pays better returns than it would have done if used in planting and giving the merely necessary attention to a larger number of trees. It is my personal opinion that under most labour conditions, such care cannot profitably be given to coconuts, and I am sure that where it is practicable to this extent, it is advisable to raise catch crops."

The next point Professor Copeland deals with is that coconuts can be left to take care of themselves, after describing how such lack of proper care results in trees below the proper size, in delay in coming into full bearing and reduction of the crop when they reach full bearing, he concludes :—"In spite of the fact that a great many people treat their coconuts in this way, I do not believe that any who has observed the matter carefully enough to frame a sound opinion will hold that the money invested in such plantations has been used to the best purpose."

" Taking up now the other assumption, that a catch crop is to be cultivated, choice must be made among the various crops which in different places are used for this purpose. The catch crop must be one which does not need to keep the land for a long enough time to interfere with the development of the coconuts, or to have to be sacrificed when the coconuts need the whole of the ground—this is equivalent to saying that it must be a crop which can either be removed at the end of not more than three years, or which can endure being shaded after that time by the coconuts. In spite of the fact that it has already been advised that if any catch crop be grown a return of fertilizers be made to the soil to balance what the catch crop removes from it, it is advisable in choosing the catch crop to give the preference to one which is known not to make too heavy demands on the soil's fertility. For instance, tobacco, if at all intensively grown, makes very heavy demands on the fertility of the soil. In other respects it would be a valuable catch crop, but for this one reason it is not in general to be recommended. So far as possible, it is advisable to give the preference to a catch crop which will be consumed on the ground, rather than to one which provides an article of commerce which contains in considerable quantity any mineral food ; and a catch crop whose seed or grain only is sold from the plantation is better than one of which the whole plant is sold."

Professor Copeland then discusses the advantages and disadvantages as catch crops with coconuts, of rice, corn, abaca or Manila hemp (*Musa textilis*) and finally cassava or manioc, concerning which he says :—

" My own preference in the choice of a catch crop, if it is possible to utilise it, is manioc. Manioc is an exceedingly heavy producer and can be made to pay a very large return for the use of the land. This can be done either by feeding the roots to stock, which however can be recommended only with certain qualifications, and often only with certain treatment, or by using the roots for the manufacture of starch or alcohol. This is not the place to discuss these industries. They are distinct and separate from coconut culture, and must be understood both in their industrial and their market relations before they can safely be undertaken. Where market conditions are satisfactory, it is practically certain that the production of manioc starch or alcohol can be made in two crops to pay for the necessary manufacturing equipment, for the clearing of the land, planting of both crops, and the cultivation needed by the land, and the return of fertilizers, and still leave a good profit for the operation of establishing the plantation.

" There are various crops, of the garden rather than of the field with which this can be done on a small scale, but there is no other which makes such slight demands upon labour, nor which can safely be undertaken on so large a scale, the reason for the last statement being that the manufactured products from the manioc are not perishable, and are marketable on the world's market.

" There is a superstition, or it might be more respectful to say belief, that manioc is an exceedingly hard crop on the soil. This is caused by the practice formerly common in the Malay Peninsula of clearing land for manioc, and abandoning it, to return to grass or bush, after harvesting two or three crops. There is no doubt that land treated in this way deteriorates very rapidly. In the Philippines land is very commonly treated in exactly the same way, except that the crop temporarily raised on it is usually rice. Still nobody

believes that rice is distinctly a hard crop on the soil ; and neither, as a matter of fact, is the manioc. The soil would deteriorate almost as rapidly if the rice or the manioc were ploughed under and nothing at all taken away from the ground. Observation has given me considerable confidence in the opinion that the soil does not deteriorate as rapidly in manioc as it does in rice. This has little to do with the relative rate of removal of mineral food, but is simply because the manioc keeps the soil more nearly in what may be called its virgin condition."—W. F. G. in TRINIDAD AND TOBAGO BULLETIN, XIV, 2.

THE GRAPE FRUIT.

The grape fruit, so named in America, is familiar to us under the name of pumelo which is derived from the two Latin words *pomum* and *melo*. Other names for it are Shaddock, so named after CAPTAIN SHADDOCK who introduced it into India, and pompelmousse. It is the *Citrus decumana* of the botanist. The name grape fruit is said to have been given to it owing to the fruits being borne in large clusters, but as this characteristic is tending to disappear under cultivation, only 2 or 3 larger fruits being produced instead of a number of smaller ones, it is reported that the U.S.A. Agricultural Department has decided to discard the name in favour of the older and more popular term pumelo. If this be so it is a move in the right direction, as the adoption of fancy names gives rise to unnecessary confusion, the extent of which will be understood when it is stated that the Secretary of this Society not long ago received an order for plants of the "grape fruit" and "grape nut," the latter being a trade name for a manufactured cereal food.

According to an exchange the Florida crop of the grape fruit amounted in 1913 to 3,125,465 boxes as compared with 5 million boxes of oranges. Besides Florida, which practically monopolises the market, Louisiana and California are also taking up the cultivation of this fruit which is very popular as an item in the American breakfast menu.

AGRICULTURE IN SURINAM.

Surinam, or Dutch Guiana as it is otherwise known, has a temperature ranging between 72° and 92° F. and an average annual rainfall of 92 inches. The chief agricultural products are cocoa, coffee and sugar. MR. F. S. LAWTON, writing in the TEA AND COFFEE TRADE JOURNAL, gives a sketch of the agriculture of this little colony which comprises only 57,900 sq. miles. In 1913 there were estimated to be 14,000 acres under cocoa plantation besides a good deal grown by small owners. In that same year the export was about 150 tons and in the year following (1914) about 185 tons, 93 per cent. of which went to the States.

Coffee flourishes here. The Arabian variety has given place to the Liberian which is planted together with rubber, the rubber affording the necessary shade for which "coffee-mamma" (*Erythrina glauca*) used to be grown. When in full bearing a crop of 1,100 lb. of dry coffee per acre may be expected. In 1913, 200 tons of Liberian coffee were exported, and last year 336 tons, while the cultivation is extending rapidly.

RUBBER.

THE PLANNING OF EXPERIMENTS WITH RUBBER.

M. BARROWCLIFFE.

Experiments with rubber trees are liable to incur many unsuspected sources of error, with the result that various experiments have obtained very contradictory conclusions. Even after taking the greatest care in the selection of the trees for the different plots it is of the utmost importance that the daily records of each plot should be recorded at least six months before the commencement of the experiment. In addition to comparing the yields of the different plots amongst themselves it is necessary to know something of the performance of each individual plot both before and during the experiment. This is best realised by plotting the yields of the plots in the form of graphs during the whole period of the observations. In this way a more comprehensive and accurate view is obtained of the extent and duration of the action of the manure or other factor under investigation—MONTHLY BULLETIN.

THE VALUATION OF PLANTATION RUBBER.

J. M. A. WYNAENDTS VAN RESANDT.

The subject with which it is proposed to deal in this article is that of the market valuation of plantation rubber, and the question will be raised as to whether planters now obtain for rubber sold its actual value.

Many planters find matter for astonishment in the fact of widely differing prices being fetched in the market by different lots of rubber from the same estate. The reason frequently given for these divergences is an apparently trifling difference in colour, or the fact of one lot not being so "nicely ribbed" as another.

The writer received the other day a letter stating that the rubber from a certain estate, *although considered as being of standard f. a. q.*, fetched *2d.* less than top price, the only reason being that the sheets were *not ribbed*. This shows quite plainly that plantation rubber is given a valuation largely on its appearance. This position is surely absurd.

A solution of this question would be the standardization of all plantation rubber. Notwithstanding all the trouble and the efforts of some prominent men, the standardization of plantation rubber is still far from solved. It is obviously possible to make a standard product on each estate, but it is more difficult to make the same standard quality on all estates. This would only be possible if everyone worked with the same machinery, used the same method of manufacture, the same smoking material, etc. So long as the conditions on the various estates are so different, it will be almost impossible to produce a standard product. I cannot think that companies

would be willing to change their factories and machinery just to be able to make the same quality of rubber as their neighbours. If we had found the secret of making rubber as uniform as hard Para rubber at a minimum cost price we could do away with our present machines, replace them by more simple ones, and the standardization of plantation rubber would be accomplished. In such circumstances the appearance of the rubber would be the same, and it would therefore be difficult for buyers to maintain price differences according to appearance. Although many kinds of rubber come very near to hard Para in appearance, the right method of preparation has not yet been found, and I am afraid that until this has been attained our rubber will fetch a higher or lower price according to appearance.

CENTRAL RUBBER STATION FORMED IN JAVA.

At the Batavia Rubber Exhibition and Congress Mr. Foll, assistant to Professor van Itterson, proved clearly how little the appearance of rubber can be correlated to its inferior qualities. He told us that he had asked several estate managers to send him samples of their rubber and mark these samples in accordance with their higher or lower market value. It happened in several cases after these samples were vulcanised and tested that No. 1, which got the best price, was of less value to manufacturers than say No. 6, which obtained a poor price. This showed clearly the empiric and false basis on which the rubber was valued.

At the close of the Congress Dr. Lovink, the Director of Agriculture in the Netherlands East Indies, asked some directors of estates, visiting agents, and leading planters to be present at a meeting he proposed to hold. At this meeting, at which the writer was present, he proposed the establishment of a central rubber station. This station would be provided with complete testing installations and would have the following objects in view:—

(1) To guide the planters as to the method of preparation to follow, after having tested their rubber.

(2) To give a certificate of the quality of the rubber which is sent to the rubber market.

This, I think, is a most important matter, and it is to be hoped that in this way some influence will be exercised on the brokers and buyers of rubber in Europe. I know that in the Straits, F. M. S. and Ceylon there are testing stations of a kind, but I doubt if they are used for this purpose. I would therefore ask all rubber planters and those interested in plantation rubber to join the Java planters in their efforts to do away with the empiric valuation of their rubber. This can be reached by standardization, and a step in the right direction would be made by establishing central rubber stations (all working upon the same lines), and sending a certificate showing the qualities after testing of an average sample of each consignment. The directors of rubber companies at home can do a great deal to help us. It frequently happens that the directors accept forward contracts for crepe as well as for smoked sheet. In this way it is already impossible for the manager to make only one kind of rubber. If only block rubber, similar as being made on Lanadron Estate, were made it would be difficult to do any "hand testing."

Dr. Lovink, our Director of Agriculture, has taken the initiative in the establishment of a central rubber station, on the lines as above explained. What countries and planters will join us and help to put an end to the fancies and caprices inseparable from the present system?—India Rubber Journal.

THE RUBBER TRADE IN JAPAN.

The Japanese rubber trade has not escaped the effects of the British embargo on the export of rubber from home and colonial ports. Ceylon and the Straits Settlements have in the past formed the chief source of the Japanese crude rubber supply, and the continuance of the embargo for a prolonged period would naturally have meant serious loss to the manufacturers of that country. The matter was taken up by the foreign and agricultural departments of the Japanese Government and requests made that Great Britain except Japan from the embargo conditions; resulting in an arrangement, effected March 3, by which the embargo has been lifted on rubber exports to Japan, on condition that the Government of this country shall control re-exports and also the exports of manufactured rubber goods so that they positively shall not reach any enemy country. The ordinance issued by the Department of Agriculture and Commerce, under date of March 3, states that any person desiring to export crude rubber or rubber goods must make application to the Minister of Agriculture and Commerce, naming the variety and quantity of the goods to be exported, the ports of shipment and destination, the name of the consignee and the trade-mark. Any person exporting goods without official permission is liable to fine and imprisonment. Applications for permit to ship goods to British and Russian ports are especially likely to be granted.

The export trade of this country has in the past been chiefly with China where there is a demand of jinrickshaw tyres and also a small but gradually increasing trade in rubber tyres for bicycles. Chinese roads, however, are not especially suited to bicycles, and until these are improved there will probably not be any very large export of this commodity. So keen a competition has developed during the past year in the Japanese tyre trade that one of the large companies—the Dunlop Rubber Co. (Far East) Limited—has changed its policy of distribution and is now seeking an extension of its trade with China rather than among home consumers.

Japanese planters now control in Johore and Borneo 46 plantations on which rubber is cultivated. These plantations cover an area of 92,871 acres, of which 39,045 acres are under cultivation, with 31,813 acres planted. Some of this area was opened as early as 1906, but the greater portion of it, or about 27,750 acres, came under cultivation during 1910 and 1911. The number of labourers employed on these various estates ranges from a very few on the smaller plantations up to 1,053—this latter number being employed on the Batu Pahat Rubber Estate at Suligarten.—India Rubber World.

MANURING RUBBER.

The object of this experiment was to determine the advantage, if any, in the use of the ordinary fertilizers to increase the yield of rubber during a tapping season. A block of 1,000 trees was divided into 10 plots numbered 1 to 10. The odd sections were left unfertilized for check, and the even sections fertilized with equal amounts of phosphoric acid in the form of superphosphate, potash in the form of potassium sulphate, and nitrogen in the forms of sodium nitrate and ammonium sulphate. The trees were

measured at the beginning and at the end of the experiment. The sodium nitrate was divided into four applications, but rainy weather destroyed the results of the tapping after the last application, so that the results are tabulated for only three series of tappings with three-fourths of the nitrate.

Ten tappings were made during September, October, and November, and five during February. Sodium nitrate was applied just before each of the tappings. In the three series of tappings, results per tree were as follows:—

EFFECT OF FERTILIZERS ON YIELD AND GIRTH OF RUBBER TREES.

Plot No.	Fertilizer.	Yield.	Girth of Trees.	
			At beginning of experiment.	At end of experiment.
		Ozs.	Inches.	Inches.
1	No fertilizer ...	1·54	16	17·9
2	Superphosphate, 375 pounds, & potassium sulphate, 125 pounds	1·57	15·97	18·5
3	No fertilizer ...	1·1	15·75	19·6
4	Superphosphate, 375 pounds; potassium sulphate, 125 pounds; and ammonium sulphate 375 pounds ...	1·4	17·23	19·2
5	No fertilizer ...	1·32	16·9	19
6	Superphosphate 375 pounds, potassium sulphate 125 pounds, and sodium nitrate 375 pounds	1·4	16·34	18·4
7	No fertilizer ...	1·43	15·55	18·4
8	Ammonium sulphate 375 pounds	1·55	14·78	16·5
9	No fertilizer ...	1·44	16·5	18·1
10	Sodium nitrate 375 pounds ...	1·48	15·2	17·7

Comparing the yield per tree from each of the fertilized plots with the average from the two unfertilized plots on either side, plot 2 exceeded plots 1 and 3 by 19 per cent.; plot 6 exceeded plots 5 and 7 by 5 per cent., plot 8 exceeded plots 7 and 9 by 8½ per cent., and plot 10 exceeded plot 9 by 3 per cent. Had all the scrap been collected, the nitrate-fertilized plots would have made a better comparative showing. The trees on these two plots retained more rubber after each tapping that had coagulated on the trees This was more noticeable in the case of plot 10, fertilized with nitrate alone.

With the exception of plot 3, the largest increase in girth is in the section fertilized with superphosphate and potassium sulphate. Why it should be greater in this case than in that of the trees fertilized with these fertilizers plus ammonium sulphate or sodium nitrate is hard to say, but the same was noted in measurements of trees on which an experiment was made in 1909 and 1910.

In general, the results show an increased yield resulting from the use of fertilizers. The increase varies from 3 per cent., in the case of nitrate alone, to 19 per cent., in the case of superphosphate and potassium sulphate.

Superphosphate and potassium sulphate, in combination with ammonium sulphate, show a greater increase than the same two in combination with sodium nitrate. Superphosphate, potassium sulphate, and sodium nitrate show an increase of 19 ounces between the first and third tappings. The largest yield per tree was obtained from superphosphate and potassium sulphate. The next largest from ammonium sulphate alone, though this was only 0·07 ounce greater than that obtained from three-fourths as much sodium nitrate. The difference in cost of material and application would perhaps be the determining factor in deciding between these two. The largest difference between the yield of fertilized and adjacent unfertilized trees was also obtained in the case of potassium sulphate and superphosphate.—REPT. OF THE HAWAII EXPT. STATION, 1914.

CEYLON OUT-PUT, 1914.

From January 1 to December 31, 1914, 35,318,269 pounds of native crude rubber was exported from Ceylon, as against 25,433,551 pounds during the same period of 1913; showing an increase of shipments of 9,884,718 pounds. Considering statistics from August 1 to December 31, 1914, during each of these five months, in spite of the fact that the war was in progress, the exports of rubber from Ceylon were much heavier than for the corresponding period of the previous year—the aggregate increase amounting to 4,709,396 pounds. Although public auctions were suspended at the commencement of the war, and in spite of the fact that figures representing private sales of rubber are unavailable, statistics in hand show that 13,334,557 pounds of rubber was offered at public auction in Ceylon during 1914, as compared with 12,013,824 pounds in 1913, and 6,260,026 pounds in 1912. Diamond-pattern smoked sheet was most in demand and was at a premium over other rubbers throughout the entire year. In fact, all good rubber was well sold, but there was a very small demand for the poorer qualities. The great European war has had but comparatively little effect upon the Ceylon rubber industry.—INDIA RUBBER WORLD.

According to BRADSTREET'S (May 1st) the United States is the greatest producer, exporter, importer and consumer of tobacco in the world. The production of leaf of all sorts averages somewhat more than 1,000 million pounds a year, having a value of 100 million dollars. About a third of this is exported in normal years but at present the trade is dislocated, though manufactured tobacco is holding its own in spite of the war, thanks to the increasing trade with the Far East (chiefly in the form of cigarettes) and Oceania. THE WESTERN TOBACCO JOURNAL gives the total output of cigars and cigarettes in 1914 as 16,496,241,576 (pounds ?), with another 404,768,725 for tobacco and snuff.

COCOA.

COCOA MANURING EXPERIMENTS IN DOMINICA.

H. A. TEMPANY.

Two series of experiments on manuring cacao were carried out: the original series began in 1901 and an additional series began in 1906. The nitrogenous manure was applied in the form of dried blood containing 12 per cent. of nitrogen, phosphoric acid as basic slag of 16 per cent. strength, and potash as sulphate of potash at 50 per cent. These manures were tried separately and together. Experiments were also tried with a mulch of grass, leaves and pods of *Pithecolobium saman* Benth. (at the rate of 100 lb. per tree), containing as percentages of the air-dry matter: nitrogen 2·116, phosphoric acid 0·156 and potash 0·644. A parallel series of experiments was made using cottonseed meal as manure, containing nitrogen 4·5 per cent., phosphoric acid 1·2 per cent. and potash 1·2 per cent. The arrangement of the plots and average results obtained are summed up in

TABLE I.

Plots.	Number of trees	Area in acres	Manurial treatment.	Average yield of cured cacao, in lb. per acre
				(1902-1913)
1	51	0·28	None	1190
2	64	0·29	Basic phosphate 4 cwt. ... Sulphate of potash 1½ cwt. ...	1430
3	59	0·36	Dried blood 4 cwt. ...	1405
4	44	0·29	Basic phosphate 4 cwt. ... Sulphate of potash 1½ cwt. ... Dried blood 4 cwt. ...	1653
5	49	0·37	Mulched with grass and leaves	1798
				(1907-1913)
6	46	0·25	Mulched with grass and leaves	1934
7	51	0·25	Cottonseed meal ...	1751
8	82 (74)	0·414	None	937
9	84 (78)	0·373	Mulched with grass and leaves	1612

These results show clearly the effects of the various forms of manurial treatment; the best result was given by the plots mulched with grass and

leaves, while the plot with complete manure came next. Examination of the results for each year shows that under orchard cultivation a period of from three to five years will usually be required before the trees settle to the state of productivity conditioned by the treatment applied.

Analyses of the soils (which are light and sandy) show that on certain plots, particularly those mulched with grass and leaves, there is a considerable accumulation of nitrogen, probably due to bacteria of the *Azotobacter* type. Laboratory experiments suggest that, in view of the small content of calcium carbonate, the ammonia formed in the early stages may serve to neutralise the citric acid formed later. A study of the soil moisture conditions indicates that while adequate covering and shading of the soil surface affect the moisture content of the upper layers of the soil to a marked degree, none of the manurial methods practised have exerted any appreciable direct effect on the moisture-retaining properties of the soil.

With regard to soil temperature, shade has a very favourable effect in maintaining it almost constant at the value of the air temperature during the coolest portions of the day, which is very suitable to the delicate nature of cacao plants, at any rate when young. A study of the relation between the yield and rainfall shows that a very heavy rainfall tends to diminish the yield.

Owing to the importance of mulches in tropical agriculture, the analyses of some of the materials used for this purpose are given (see Table II).

TABLE II.—Composition of mulch in percentages of air-dry material.

	Andropogon caricosus L.	*Cymbopogon citratus* Stapf	Mixed grass	Grass for mulch	Clippings from *Gliricidia maculata*	Pods of *Pithecolobium saman* Benth
Moisture at 100°C.	13·42	13·03	9·97	10·83	11·69	16·80
Nitrogen ...	0·66	0·51	0·83	0·74	3·12	2·60
Phosphoric acid ...	0·04	0·37	0·22	0·22	0·40	—
Potash ...	0·97	1·16	0·80	0·99	—	—

—Monthly Bulletin.

CLAYING COCOA.

The process of claying cocoa, which consists of coating it with a thin covering of very fine ferruginous clay, was originally adopted with the object of preventing the bean from becoming mouldy in wet weather, to keep it bright and uniform in appearance, and to help to preserve its aroma.

According to the West India Committee Circular the practice was introduced from Venezuela and first applied to fine estate cocoa, but with regard to that type it had not been practised to excess. In 1913, however, it was found that some small dealers were claying more or less immature

cocoa to excess, chiefly obtained from small holdings, with the result that complaints were at once received. There is little doubt that in many cases the offenders were prompted by a desire to increase the weight of the cocoa. Thanks to the action of the Trinidad Chamber of Commerce, the Agricultural Society and Cocoa Planters' Association this excessive and fraudulent claying has now been put an end to.

COCOA EXPERIMENTS IN BRITISH GUIANA.

J. B. HARRISON AND S. H. BAYLEY.

Manurial experiments carried out on cocoa trees during five years (1909-13) have furnished the following results :—

Plots.	Yields in lb. per acre.			
	Wet Cocoa.		Cured Cocoa.	
	Yield.	Probable Error.	Yield.	Probable Error.
Nos. 1, 4, 7, 11 and 16. No manure...	5,762	+ 196	2,080	+ 71
,, 3, 8 and 13. Heavily mulched...	7,482	+ 289	2,699	+ 113
,, 12 and 18. Sulphate of Ammonia	5,440	+ 426	1,963	+ 155
,, 6 and 14. Superphosphate of lime and sulphate of potash...	7,492	+ 460	2,705	+ 154
,, 5, 10 and 15. Superphosphate and sulphate of ammonia ...	6,56	+ 485	2,375	+ 213
No. 9. Sulphate of potash and sulphate of ammonia ...	6,208	+ 596	2,242	+ 217
Nos. 2 and 17. Superphosphate, sulphate of potash and sulphate of ammonia ...	6,801	+ 271	2,465	+ 99

Taking into account the probable errors, the highest total yield of cocoa during the five years has been on the heavily mulched plots which gave a minimum increase of about 435 lb. of cured cocoa, or about 84 lb. per acre over the mean of the five control plots.

The value of this increase is about $52 and the cost of the mulching approximately $66. On the other hand the application of sulphate of potash and superphosphate of lime, costing approximately $14 during the five years gave a minimum increase of 400 lb. of cocoa worth about $50. The quick

acting nitrogenous manure—sulphate of ammonia—somewhat lessened the yields both when applied alone and in conjunction with superphosphate and sulphate of potash.

The results obtained in 1913, during which no manures were applied, showed that a residual effect remained from the previous years only in the case of the mulched plots and those receiving both superphosphate and sulphate of potash, while, where sulphate of ammonia had been applied, the yields were lower than in the case of the unmanured plots.

Liming experiments carried on 36 plots showed no beneficial effect during the five years.

The effect of decreasing the shade, improving the tillage, drainage and sanitation of cocoa trees is seen in the results obtained from two acres of trees taken over by the Agricultural Department in 1910. During the last five years the yields have steadily increased from a mean of 1,064 lb. to 4,494 lb. of cured cocoa. Further experiments on the reduction of shade were carried out in 1913 on the same plots.

The results were as follows :—

	Per acre of 300 trees.	
	No. of pods.	Lb. of pulp.
Heavily shaded ...	5,589	1,204
Very lightly shaded ...	9,546	1,823

The writers consider that the removal of shade has a greater influence on the yield of the trees than the improvement in drainage and cultivation.—
MONTHLY BULLETIN.

PLANT NUTRITION.

The fundamental problem in plant nutrition is the production of sugar in the green leaf, but the investigation is seriously hampered by analytical difficulties. During the past three years considerable improvements in method have been effected by MR. DAVIS and his assistants, MESSRS. DAISH and SAWYER, and this year satisfactory proof has been adduced of the presence of free pentoses in the leaf and a method has been elaborated for determining them.

The complete method now allows of the determination of cane sugar, maltose, dextrose, levulose, pentoses, starch, and pentosans in the leaf. It has been used for numerous analyses of leaves and stalks plucked at regular intervals during the day and night, the results of which will be discussed later.

Equally important from the standpoint of crop production is the formation of starch in the grain. Analytical difficulties have hitherto prevented a satisfactory investigation, but this year the determination of starch has been put on a satisfactory basis. The existing methods may give rise to an error equal to 20 per cent. or more of the starch present: in the ordinary diastase method, for example, a loss of this magnitude may arise from the precipitation of dextrin during the preliminary processes of precipitation. A new method has therefore been devised, based on the fact that the enzyme taka-diastase transforms starch quantitatively into maltose and dextrose, no dextrin being formed: thus the errors of the ordinary method are obviated. This is apparently the only trustworthy way of estimating starch in plant tissues, and it is now being used for wheat and barley grown on the Rothamsted plots.—
ROTHAMSTED EXPT. STN. ANN. REPT. 1914.

TOBACCO.

CHANGES OF NITROGENOUS SUBSTANCES DURING THE CURING OF TOBACCO.

L. BERNARDINI.

The artificial curing of tobacco, invented by Angeloni, may be regarded as the fusion of the two processes, curing and fermentation, into one continuous process. The writer sets himself the task of investigating the changes that take place in the nitrogenous substances during artificial curing as compared with air curing; for the latter method, even after subsequent fermentation, does not succeed in giving good results in the case of fine native tobaccos.

The results of these researches were as follows:—

(1) The artificial curing process does not produce any changes in the proteid substance of the leaf.

(2) In leaves cured by this process there are none of the soluble nitrogenous substances belonging to the amino-acids which occur in air-cured leaves.

(3) In the artificial curing and air curing processes alike, the basic nitrogen contained in the leaves corresponds exactly to that present under the forms of nicotine and ammonia.

The consumption of nitrogenous substances observed during artificial curing, therefore, takes place at the expense of the amino-acids which are completely used up, while the proteid substance and the nicotine remain unaffected.—Monthly Bulletin.

TOBACCOS GROWN IN ITALY.

DR. ERNESTO PANNAIN.

The cultivation of tobaccos from foreign seeds is more important than that of native tobaccos and the yield is twice as great. On the whole, however, the yearly output of the country (about 20 million pounds) is barely one quarter of the quantity that is bought every year by the monopoly. This production might be very considerably increased, because the cultivation of tobacco is as profitable as that of any other staple. The conditions of climate and soil in Italy are almost everywhere favourable to this crop, the yield per acre is often superior to that obtained in the greatest centre of production and the quality of the product is generally very good. The Kentucky of some regions, such as Roman Campagna, Tuscany, Abruzzi, Calabria, and the district about Salerno bears comparison, as regards strength and taste, with that of the United States. Virginia tobacco has also given good results in several regions and the Levantine tobaccos, especially Xanti Yakà, grown in the provinces of Lecce and of the Abruzzi, have such an exquisite aroma, perfume and

delicacy of texture that they can stand the competition of Macedonian tobaccos even on foreign markets.

Certain difficulties are met in growing this crop ; in order to obtain leaf tobacco complex operations are necessary and these may be divided into two groups: (a) *agricultural* or *farming operations* and (b) *industrial operations.*

The former include: preparation of the soil (ploughing, spading, manuring, etc.), sowing, transplanting, hoeing, earthing up, topping and harvesting, which are performed as for any other crop. The industrial operations ars divided into *curing* and *fermentation.* By curing, the green leaves, either threaded together or left on their stems according to the system of harvesting, are subjected to a series of treatments during which, owing to the action of the oxygen of the air, of moisture, of the sun's heat or of artificial heat, they undergo a profound transformation in their external characters and in their chemical composition. The bright green colour becomes yellow, chestnut or brown according to the system followed. The greater part of the water content is eliminated, the tissue becomes more tough and elastic, the characteristic perfume and aroma of tobacco is developed, while the organic substances contained in the leaf act and react upon each other. These complex alterations are then completed by *fermentation*, which is brought about by packing the cured leaves in small bales covered with canvas, in wooden casks or in large heaps, opportunely moving them so as to prevent the heat produced by fermentation and chemical reactions from becoming too great and thus damaging the product.

Before fermenting the leaves, they are *classified* and made into bunches (*affascicolamento*) and the leaves are detached from the stem when this has not already been done at harvest time (*sfogliettatura*). Of all these manipulations curing requires most care because it is during this process that the tobacco is formed. As with the best grapes very bad wine can be made if the complex operations involved in wine-making are not carefully carried out, so an excellent plant of tobacco can yield a very inferior product if curing is done carelessly.

The production of the raw tobacco is thus a real agricultural industry which requires special technical knowledge on the part of the growers, and the product will be all the better the more the growers are aware of the importance and the delicacy of the various operations they have to carry out. Very often it happens that plants grown on adjoining plots under the same conditions of climate and culture, and which are identical in the green state, give rise to quite different tobaccos according to the care with which the curing is carried out.

In order to improve, and consequently, to develop the production of tobacco it is indispensable that tobacco-growing should be considered as a great agricultural industry. Considering the nature of curing operations it is not always possible for every small grower to have the necessary equipment and skill ; it should therefore be done by suitable establishments in each area of production. And it would also be a great advantage if the grower were left free either to export his tobacco or to sell it to the Monopoly.—MONTHLY BULLETIN.

SUGAR-CANE.

SUGAR-CANE IN WESTERN INDIA.

The cultivation of sugar-cane is the most paying industry to a cultivator in Western India wherever irrigation facilities exist.

This is largely due to the extent of the local market there is for the outturn which is very largely the unrefined sugar (*gul*).

The climatic conditions are obviously unfavourable; but when a cultivator is given the privilege to put on his land water in unlimited quantities, then the only limiting factor becomes capital.

The manuring and watering is perhaps the heaviest ever given to sugar-cane in any part of the world. The costs of cultivation and marketing the outturn as crude sugar varies from Rs. 350 to Rs. 500 per acre but the gross profits realised may be anything from Rs. 400 to Rs. 800 per acre.

In irrigated tracts, frost is the limiting factor in distribution. Whilst short-season canes are available still they do not give as good outturns both in quantity and quality as do the varieties that need at least twelve months to mature.

Consequently, the profits are less even so that other garden crops become more paying.

RATOON, ROTATIONS AND MIXED CROPS.

The crop is never ratooned except in the Poona district. More than one ratoon crop is rarely, if ever, taken. Ratooning has not been found to be economical. The outturn of the ratoon crop is never so heavy as that of the plant canes whilst weeding becomes a very heavy item of expense. Deep-rooted grasses and other weeds become rapidly and thoroughly established. They make irrigation impracticable; the land becomes foul and deteriorates in physical condition. The cost of bringing such land back again to the necessary tilth is rarely within the means of the small proprietor. Waterlogging and the rise of salts often appear in quick succession. These are largely due to the heavy waterings whilst the natural drainage of the tract is not attended to. For these reasons, sugar-cane is never grown continuously. Good cultivators recognise the necessity of a rotation that will enable them to clean and thoroughly cultivate the land.

Cane is rotated with dry crops or other garden crops as ginger, turmeric, potatoes, etc. Often 4 to 6 years are allowed to intervene between two crops of cane.

A rotation that is considered good is :—

1st Year.—Sugar-cane. *2nd Year.*—Sorghum (rain-fed; thrives on the residual manures; gives an opportunity to clean the land). *3rd Year.*—Spanish peanut or Small Japan (early varieties of groundnut) or *San* (as green manure).

In the intensively cultivated garden lands, along the coast, near Bombay, the order of crops taken are :—

1st Year.— Betel-vine. *2nd Year.*—Ginger (or Turmeric). *3rd Year* —Sugar-cane. *4th Year.*—Plantains.

Catch crops are often taken during the first three months of the growth of the cane. Maize is a very popular crop because it attracts the stem-borer which then seldom attacks the cane. The crop is taken solely for fodder purposes. (Fodder is always an acute problem with the Deccan cultivator.)

Other catch crops are onions, cucurbits, *Cyamopsis psoralioides*, (as green manure and vegetable), castors and tobacco.

Tobacco is planted along the water-courses and takes about five months to mature after the seedlings are transplanted.

This combination is not good because the cane commences its period of rapid growth after the first three months and then chokes out the tobacco.

A common combination of varieties to keep away jackals is often seen where hard reed-canes are planted on the outside.

CULTIVATION.

This is a very heavy item of expense to the cultivator. Nearly half of this expenditure can be reduced by one thorough ploughing with the Eagle gallows plough followed soon after by the disc harrow or Orwell's cultivator. The Acme harrow prepares the best tilth for planting.

The Planet Junior ridger has been found to be very effective as a ridging implement as well as in weeding and earthing. It has been estimated to save about one-third of the expenses of the after-tillage.

In this case, it is the row system of planting that is economical. By this system, four lines of cane sets are planted in furrows that are about 5 feet apart.

In planting, the use of the terminal sets, i.e. the three or four internodes of the cane just below where the leaves are lopped off, has experimentally been shown to give better cane with an increase of 10 per cent. on the net profits.

This top portion of the cane has been found to contain a larger percentage of reducing sugars, and also, that it adversely affects the quality of the crude sugar that is turned out.

VARIETIES.

The Manjri Experiments have brought out the superiority of an indigenous variety, *Pundia*.

It is a soft, juicy and thick cane. It has an average content of 15 per cent. sucrose with a little more than ½ per cent. of reducing sugars. The cane is a gross and shallow feeder, needs heavy manuring and irrigation ; it needs to be acclimatized before it can be introduced into a new tract.

The red and green varieties of Mauritius cane give a heavier yield but the juice is one per cent. inferior in quality to that of *Pundia*, besides, it takes two months longer to mature than the indigenous *Pundia*.

Other varieties need less water and manure but they contain a larger per cent. of reducing sugars and the canes are harder to crush.

MANURING.

It has been found that the quantity of manure necessary for maximum crop production bears a definite relation to the quantity of water applied to the land.

The cultivators, generally, apply as much farmyard manure as they can get, i.e., about 30 to 60 cartloads.

This they supplement with a top-dressing, as much, it is stated, as from 2 to 3 tons of castor-cake or fish manure per acre.

A summary of the results gained at the Manjri Experimental Station are as follows :—

(1) The quantity of water used can be reduced to about one half.

(2) Manures furnishing organic matter are essential for successful cultivation.

(3) Farmyard manure should be applied at the rate of 25 cartloads to the acre, or its equivalent in green crop manures, poudrette or megass.

In the latter instance, at least 5 cartloads of farmyard manure should be used.

(4) A top-dressing equivalent to about 100 lb. nitrogen per acre applied in oil cakes, preferably safflower cake applied when the plants are 2 to 3 months old is recommended.

(5) If available cheap, half the above quantity of the top dressing should consist of sulphate of ammonia. (This has been found to give about 40 per cent. greater outturn than a top dressing of safflower cake alone).

HANDLING THE OUTTURN.

It has been found that the quality of the *gul** is not affected by manures but very largely by the time of harvesting. Experiments have been conducted to ascertain the stage of maximum sugar content by the use of a Brix Saccharometer and correlating its reading with actual analyses of the juice at different stages of the maturing cane. By this means a practicable method has been devised of ascertaining the "ripeness" of the cane.

The quality of the *gul* turned out then depends on the operations connected with its preparation, e.g., clarification, speed of boiling, striking temperature and method of cooling.

In crushing the cane, by means of the iron mills an increase of 14 to 22 per cent. in the outturn of juice has been demonstrated over the country methods.

The power crusher can effect a saving of Rs. 100/- per acre by its use, but to be economical needs an area of at least 25 acres ; this is rarely possible in these areas of small holdings.

In the evaporation of the juice a Multiple Furnace has been devised which saves much labour, fuel, and time. It consists, in principle, of the utilisation of the waste hot gases in evaporating the juice in a series of pans.

* In the local market the rice of *gul* (or crude sugar) varies according to the quality and colour.

SUGAR-MAKING.

The Haddi process of sugar-making is admitted to be the most economical but as long as *gul* commands a price just a little less than that of sugar there will be no opening for sugar-making.

The establishment of a refined sugar industry on a co-operative basis is now engaging the attention of the Bombay Agricultural Department. This is largely the result of many factors :—

(1) The increase of the acreage under sugar cane has lowered the price of *gul*.

(2) The increased imports of refined sugar show that the taste for this is on the increase whilst that for *gul* is decreasing.

(3) The immediate demand for sugar due to the war.

H. VAN BUUREN, (JR.)

BRITISH SUGAR.

From replies received from the Governors of British Guiana, Fiji and Mauritius to a circular letter addressed to them by the West India Committee it is estimated that under favourable conditions the output of sugar in British Guiana could be raised to 2½ million, that of Fiji to 95,000, and of Mauritius to 305,000 tons a year. In the reply received from the Governor of Trinidad the average annual sugar output for 20 years past is given as 52,715 tons. At one time (1895-6) the output was nearly 70,000 tons, and among reasons for the decrease are given the substitution of more profitable crops, e.g., coconuts, and, to a less degree, cocoa, and lime. Though of late much attention has been given to the development of the sugar industry by the selection of better varieties of cane and the adoption of better methods of cultivation, no material extension is expected to take place in the near future.

In this connection it may be mentioned that a report of a Joint Committee of the Chamber of Commerce and the Agricultural Society of Trinidad and Tobago upon the question of placing colonial sugar on as favourable a footing in English markets as British beet, has been adopted prior to a representation being made to the Secretary of State for the Colonies.

The UNITED STATES BUREAU OF PLANT INDUSTRY discusses the question of growing groundnuts in the cotton belt owing to the expected shortage of cotton seed for oil purposes. The idea is to make oil from both cotton and groundnut seed so as to keep the mills working regularly. It is stated that shelled Spanish groundnuts contain 50 to 52 per cent. of oil and that with up to-date presses 42 to 44 per cent. is extractable. The estimate is that one gallon of oil should be got from 1 bushel of good nuts weighing 30 lb. A ton of the Spanish nut, after cleaning and shelling, is expected to yield 350 to 400 lb. first-grade oil and 800 lb. cake., the oil being saleable at 75 cents per gallon for first grade and 35 to 40 cents a gallon for soap making.

FIBRES.

THE TWO JUTE PLANTS.

The seeds of *Corchorus capsularis* are about twice as heavy as those of *C. olitorius* and therefore require to be sown at twice the rate of the latter. The yield of seed from the two species is also in the same proportion. Both seeds are irregularly eight-sided in shape, but differ as regards colour, the former being uniformly brown and the latter being bluish—or brownish-green or brown according to the degree of maturity. Thus if a sample of *C. capsularis* seed contains any greenish seed it is mixed, but this is not necessarily the case with seeds of *C. olitorius*. The fruits of the former are round and much warted, those of the latter, long and cylindrical and much less warted.

In growth, the plants of *C. capsularis* develop more rapidly during the first three weeks but are gradually overtaken by those of *C. olitorius*, which sometimes attains a height of 18 feet, and which have much thicker, and more uniform, stems. In addition to tapering, the stem of *C. capsularis* has a tendency to branch before flowering, with the result that the uniform retting of the fibre is very difficult.

The leaves of the two species may be distinguished by the angle of the apex, that of *C. capsularis* being less than thirty degrees, whilst that of *C. olitorius* is nearer fifty degrees. The leaves of the former are also bitter to the taste and are used medicinally, whilst the latter are edible and used as a vegetable.

With regard to the quality of the two fibres, there is little difference, though that of *C. capsularis* has more gloss. Both fibres are used for almost the same purposes and some authorities consider the *Olitorius* fibre to be the finer and stronger. The percentage of fibre in *Olitorius* plants is remarkably constant among plants of 7 to 12 feet high, whereas in *Capsularis* the percentage rises with the height. The result of a series of analyses gave an average of 5·63 per cent. of fibre in *Olitorius* without leaves and a percentage loss of matter in retting and drying of 78·6; in the case of *Capsularis* the averages were 5·33 and 85·50 per cent. The percentage of matter lost in retting and drying includes moisture and decomposition products, and is greater in the case of *Capsularis* owing to the higher percentage of water in these plants. This is in agreement with the nature of this plant, which is more adapted to districts with a high rainfall than *Olitorius*.—Monthly Bulletin.

THE CULTIVATION OF SEA ISLAND COTTON.

Soil.—Should be fairly good land, and must be well drained. Cotton requires plenty of sun, and should not be planted under the shade of any trees. It should not be exposed to strong winds.

Preparation of Land.—At the end of October or beginning of November, plough or fork the land over, well burning allweeds; then let it lie a couple of weeks, when lumps will be readily broken down.

Planting.—Sow several seeds at each spot two and a half feet apart in straight rows five feet apart. The seeds should be sown in wet weather at the end of November or early in December. One acre of land will require about four or five pounds of seed.

After Treatment.—After the seeds have germinated the plot should be examined, and seeds should be supplied to places where the first seeds have failed to germinate. It will be seen that where seeds have germinated, there are generally several seedlings at each place, and they must be thinned out by removing the weakest plants one by one at intervals of a fortnight, until only one plant (the strongest) remains.

Kill weeds by a light hoeing once or twice a month until the bushes begin to cover the land. When hoeing among cotton, see that the soil is worked up towards the stems of the cotton bushes, so as to afford them more support against winds.

Report the appearance of insect pests to the District Commissioner or Inspector of Immigrants (who will forward the information on to the Superintendent of Agriculture).

Picking.—The cotton is picked from the pods after they have burst open and the cases have become dry. Cotton must not be picked wet or until the cases of the pods have become brown and perfectly dry. The best time to pick each day is after 10 o'clock, when the sun will have dried up dew and other moisture. Do not pick cotton while it is raining. See that the cotton picked is clean and that no pieces of leaves or pods are included. Stained cotton and small immature pods are useless and should not be gathered. The Government will purchase mature clean seed-cotton at the Experimental Station, Lautoka, or certain District Commissioners' Stations, at the rate of 3*d.* per lb. in lots to suit growers.—Fiji Planters' Journal.

The Oil, Paint and Drug Reporter (May 3rd) in reviewing the position of the oil trade quotes the comparative market rates of the heavy oils at that date. Linseed oil varied from 61 to 63 cents (American) per gallon. Olive oil 90 to 94 cents. groundnut oil 65 to 70 cents. cotton seed oil and rapeseed oil 82 to 84 cents. For the following the quotation is per pound:—Coconut oil (Ceylon) $9\frac{3}{4}$ to $10\frac{3}{8}$, (Cochin) $11\frac{1}{2}$ cents, Palm oil (Lagos) $9\frac{1}{4}$ to $9\frac{1}{2}$ cents, Palm Kernel oil $11\frac{1}{2}$ to 12 cents, Soya bean oil $6\frac{1}{4}$ to $6\frac{1}{2}$ cents China wood oil $6\frac{1}{2}$ to $6\frac{3}{4}$ cents.

COFFEE.

THE CULTIVATION OF COFFEE.

The first matter to be considered in the establishment of a coffee estate is the selection of seed and the preparation of nurseries. Emphasis is placed upon the importance of selecting only the best, full, perfectly shaped beans for sowing, and upon the selection of new and fertile ground for the nursery beds, in which care should be taken not to sow the seed too close together. The land selected for the establishment of the coffee trees should be a rich sandy loam containing an abundance of humus with a well-drained gravelly subsoil. If clay soils are used, they must be frequently limed. Instructions are given in the bulletin under review for the transplanting of seedlings. Holes are dug about 5 feet by 6 feet apart, and about 3 feet deep. The bottom of the holes should be broken up so that the young tap root of the nursery plant can easily penetrate the soil. When the planting season arrives with the rain, the plants are carefully lifted from the nursery beds, eac with a ball of earth round its roots, and planted one in each pit, care being taken to fill the pit with the top soil, and to press the plant firmly into its place without ramming the soil too tightly.

Under favourable conditions, a coffee plant will live from thirty-five to sixty years, but many trees on every estate are exhausted in ten or twelve years by unskilful treatment or the attacks of borer or leaf disease. Consequently arrangements must be made to have a constant succession of young plants coming on in the nursery to replace those which have to be taken out.

In the chapter dealing with the cultivation and preparation of the soil, it is observed that coffee is largely a surface rooting and surface feeding plant, so that the utmost care must be taken about cultivation, and fully grown coffee should not be dug deeply at all if it can possibly be avoided. After describing the methods of clearing lands for coffee, the interculture of the crop is considered and the importance of a light surface cultivation amongst established coffee is emphasized.

An interesting section in the present chapter is that dealing with the renovation of old coffee. Briefly this consists in sawing the trees off at the ground level immediately after they have borne a heavy crop. All the shade trees are felled and the land turned up in big clods. The light branches of the coffee and shade tree and all the litter are then spread over the field and the whole given a qu'ck burn. The soil is again forked and an application of about a ton per acre of good slaked lime is then worked into the top soil. Erythrina and new shade is then planted. The coffee stumps sucker, and each is allowed to grow the two most healthy shoots thrown out. After two years the suckers are reduced to one, and in three or four years a complete new root has been formed and a new healthy tree produced. The results of the above treatment have been most successful and have repaid the cost, which is considerable.

After calling attention to the necessity for draining, consideration is given to the question of shade. It is stated that in South India it is necessary to grow coffee under shade. Probably the best all round shade tree in Southern India is the silver oak (*Grevillea robusta*), which possesses nearly all the good points required for a shade tree amongst coffee, namely, growth not too large, big spread of branches, retention of leaves in the hot weather, root system not too near the surface of the soil, and lastly, immunity from the attacks of insect or fungoid pests which attack coffee. In the course of the developments of the estate the shade trees have to be regulated, and detailed instructions are given as regards carrying this into effect.

The next two subjects dealt with are pruning and weeding. If the coffee plant is left alone, it forms a tall bush with a number of long, upright primary branches on which the berries are chiefly borne. In this form it is easily broken by the wind, and the crop is not easy to gather without breaking the branches. For this reason the young trees are usually topped by cutting off the leading shoot with a sharp knife when they are about five feet high. A common system of pruning is to take off the alternate secondary branches to allow for the extension of the tertiary branches on which the berries are chiefly borne. Sometimes this is accompanied by the development of a mass of suckers : these must be removed, and the process is known as 'handling' the trees. The worst weed on the South Indian coffee estate is grass. A constant war should be waged against grass and it should be remembered that the first principle in destroying this or any other weed is to attack it before it has time to ripen seeds. Whereas vegetation of this kind growing in the soil is exceedingly harmful, a mulch of leaves derived from weeds or shade trees is very beneficial. The reasons for the good action of mulches is now well known to planters, and it may be pointed out that this method of soil improvement and manuring is becoming widely recognised all over the world in regard to nearly every orchard cultivation.

One of the last chapters, and by far the longest, is that dealing with the manuring of coffee. From the information already presented in this abstract it will have been realized that the previous sections dealing with cultivation contain much sound, practical knowledge bearing directly upon the successful production of the crop in question. The chapter on manuring, though interesting and enlightening, cannot be commented on in the same way. It explains the general principles of plant nutrition, the general composition of manurial substances, and gives some attention to the valuation of manures, whilst a note on the mixing of fertilizers is appended. But a search through this information for references to coffee is rather disappointing ; it is noticed however, that the general practice in applying manures in Southern India is based upon their application in connexion with the occurrence of the monsoon. It seems that potash should be applied before the monsoon, and phosphoric acid half before and half after the monsoon, the after monsoon application to be in an available form such as superphosphate. The nitrogen should be applied after the monsoon in an available form. Attention is called to the cheap and valuable nature of waste materials on the coffee estate for manurial purposes. It is urged that coffee is benefited by the cultivation of suitable leguminous cover crops provided the soil is first got free from weeds.

The last chapter deals with the handling of the crop. This subject, which involves such important points as picking, pulping, fermentation and packing, is most disappointingly short. It would be of interest to have found a full description of the method of fermentation adopted in Southern India, and the methods and machinery employed in the drying and handling of the crop. Apart from this criticism and the suggestion that more space might have been devoted to pests and diseases, we may confidently state that the bulletin under review is likely to prove of great service to those who are in possession of estates, and to agriculturists who intend embarking upon such an enterprise under similar conditions to those obtaining in Southern India.

—The Agricultural News.

CEYLON PRODUCE IN THE DRUG TRADE.

The Chemist and Druggist thus reviews the situation in respect of Ceylon produce of importance in the drug trade :—The shipments of coconut oil declined by some 1,600 tons, due chiefly to the closing of the German markets, but it will be seen that largely increased quantities were shipped to the United Kingdom. In fact, since the outbreak of war, shipments of copra to London began in earnest for the first time, and have gone on steadily, and at the end of the year the total shipments amounted to 562,520 cwt., against 1,500 cwt. only in 1913. We believe that active steps have been taken to deal with the manipulation of this and other products of the coconut palm in this country, and it is to be hoped that a large proportion of the trade will be retained after the war.

The decrease in exports of Cinnamon is practically double that recorded in 1913, and particularly noticeable in shipments to the Continent. In the past Germany has to a certain extent been a distributing centre, and was by far the largest customer, but the decrease in quills was 720,000 lb., and 100,000 lb. less of chips was also wanted last year, Similar decreases took place to Italy and Holland. Spain, however, took more, and last year proved the second best customer to the United States, which country imported 674,000 lb. quills against 360,000 lb. in 1913. Great Britain received 132,000 lb. more chips, but less quills, and the whole decrease of 860,000 lb. meant a drop of 26 per cent.

It will be seen that there was a decrease of 47,430 lb. in the shipments of cardamoms, and the shortage would have been still larger had not the United Kingdom taken an increase of 58,314 lb. The falling-off in shipments to Germany, Turkey, and India is very marked, and as these countries have taken large quantities in previous years, it has had the effect of depressing the market for cardamoms. Since the commencement of the war there has been practically no market in Ceylon, and a large proportion of bleached cardamoms—usually sold in Colombo—have been shipped to London, where they are difficult to sell at the moment. Citronella oil shows a decline of practically 150,000 lb., or about 10 per cent. less. The United Kingdom took 26,000 lb. less but the United States, the next largest consumer, bought 28,000 lb. more. Germany, the third largest consumer, shows an extraordinary decrease of 197,000 lb., or 70 per cent. The Australian Commonwealth is evidently becoming a valuable customer for citronella oil, imports increasing by almost 50,000 lb. The State of Victoria practically trebled its imports, and those for New South Wales were almost double Japan and China also took increased amounts. Undoubtedly war has considerably upset this market locally, and we understand that there are large stocks in Ceylon, owing partly no doubt to lack of freight.

SOILS AND MANURES.

THE ABSORPTIVE POWER OF SOILS.

A study of the absorptive power of soils for salts used as fertilisers has been made in Mauritius by Mr. de Sornay, Assistant Chemist on the staff of the Agricultural Department of that Colony, and his conclusions on the subject are of considerable value.

In the case of ammonium sulphate it was found that sandy soils have practically no power of retaining the ammonia, and that the absorption of ammonia salts is associated with the humus and clay contents. Besides the decompositions which take place in the soil, clay absorbs and retains ammonia mechanically. A fact which must not be overlooked is that soils lose their lime contents when frequent applications of ammonia salts are made. The acid of the salt combines with lime to form a salt of lime, and when ammonium sulphate is used the salt produced is sulphate of lime which can be readily carried down into the subsoil. Analyses tended to show that the proportion of lime found in the washings is in direct relationship to the quantity of sulphuric acid. Both humus and iron colloids when present probably increase the absorptive power for sulphate of ammonia. In the case of nitrate of potash there is a marked tendency for the potash to be retained by soils, the retention being associated with clay.* The nitrate undergoes double decomposition and the acid combines with the bases in the soil The base is generally lime and the quantity of lime in the washings is in direct relationship to the nitric acid.

In the case of sodium nitrate it was found that a relatively high proportion of nitrate can be washed away when rain falls soon after application. It is not correct to infer that by being washed down to deeper layers of soil the nitrates are lost, since they again rapidly rise by capillarity.

In the case of phosphatic manures the retention of phosphoric acid does not always accrue to the benefit of the plant.

When superphosphate is employed the soluble monobasic phosphate combines with lime to form a dibasic phosphate, but if the soil be poor in lime it decomposes and combines with iron and alumina. Monobasic phosphates combining with humus form stable and useful compounds which are not capable of reacting with mineral compounds in the soil. Where iron and alumina exist in proportions varying from 30 to 40 per cent. with a lime content of 0·3 to 0·45, it is probable that the acid phosphate of lime present in superphosphates is changed into phosphate which is practically insoluble. Where the humus and lime contents are low it is impossible to regard these as the factors in the fixation of phosphoric acid. The combinations of phosphates with hydrated compounds of iron and alumina are of little use to plants. It would thus appear that the results arrived at by the application of phosphate is not always reached, inasmuch as the fixation is in the form of insoluble compounds.

* As double hydrated silicates of alumina.

To summarise, the absorption of free or alkaline bases always takes place in a soil, and the degree of such absorption varies according to the nature of the soil: and the soil will give back the ammonia and potash retained but with difficulty and only after good showers of rain.

Soluble salts which are carried into the lower layers of the soil will be brought up again by surface tension and capillarity.

If the soil is allowed to become compressed loss of manurial matter will occur during heavy rains by soil being actually carried away in the washings. It is therefore necessary that manures should be well covered over: but where the soil is preserved in good porous condition the loss of fertilising elements even during very wet weather is not considerable.

GARDEN SOILS.

In a lecture by Mr. Thomas Challis referred to in the Gardeners' Chronicle some practical observations on this subject, to which we should like to direct attention, occur.

We are told that soils for garden purposes should contain a certain proportion of sand, clay, and lime, with a small quantity of humus. When the clay is heavy or plastic, a greater proportion of sand, lime, and humus is required to make it workable and also to admit air to the roots; for soil that does not allow air and water to pass freely through is of very little value. In nine cases out of ten where failures occur in plant or fruit cultivation, it is found to be due to an insufficient amount of either calcareous or silicious matter in the soil. The lower, flatter, and more moist the situation of a garden, the greater is the proportion of sand and humus required in the soil, and the greater the quantity of humus and lime the less sand is required to temper the clay. A good, easily-cultivated loam is composed of at least one-half fine silicious or calcareous sand, one-third of clay and humus, and the rest chalk.

The chief constituent in all composts, especially where permanency is required, is calcareous and silicious sand, not so much perhaps for its nutritive properties as for its effect in rendering the soil pervious to water and air. Any soil deficient in either sand, lime, or humus is certain to end in failure. It is not altogether the constituents of a soil, with regard to its organic and chemical ingredients, that should be studied, but also its mechanical texture.

THE USE OF ARTIFICIAL MANURES.

The use of fertilisers is often regarded as the most essential and characteristic feature of the practice of scientific agriculture. Courses of agricultural instruction usually give much more attention to this than to any other part of the subject. There are various books, and good books, devoted to the subject of fertilizers and their use. Every general treatment of one of our crops devotes much attention to this phase of its proper culture. In one book on the coconut, there are nearly 150 pages devoted to fertilizers. The planter is

continually urged to use them, and the favourable experience of those who have done so is constantly invoked for his guidance.

There is no question as to the general possibility of securing by means of fertilizers greater yields than will be obtained without them. There is likewise no question as to the profits which can usually be obtained by the judicious use of fertilizers. Neither is there any doubt that such manures as are produced on the farm can be used to good purpose as fertilizers, and that failure so to use them is always very wasteful.

Nevertheless, the dogmatic treatment which the subject often receives in editorials and appeals to the farmer, and in many other places, is thoroughly misleading. There are two general reasons why this is so. In the first place, the evidence is not what it seems to be. It is the almost universal custom outside of well conducted experiment stations to apply fertilizers to the land, to observe the increase in production of crops, and to construe this as measuring the profits. It needs no consideration to show that increased yields and increased profits are by no means the same thing. Before a profit from the use of fertilizers can be computed, the farmer must, of course, take into account the cost of fertilizer, and the cost of operations incidental to its use, such as, for instance, harrowing it into the ground. In careful work there must still be considered interest on the money tied up, the future value of fertilizers still remaining in the soil, and the value independently of fertilization, of treatment given incidentally to the use of the fertilizer. It is rare indeed to find a farmer who keeps his books in such a way that he knows at all accurately what the application of fertilizers has cost him. Even the manure of his own stock is rarely applied without some expense, whether for fencing, herding, hauling, or otherwise.

There is no kind of experimentation which requires more perfect understanding of the subject and knowledge of possible sources of error, and care in guarding against unreliable results, than does the testing of the value of fertilizers. In such experiments, when carried on as field or plot cultures, the soil takes the place of the chemist's laboratory apparatus, and the soil is complex far beyond anything in the chemist's laboratory. The gross chemical composition of the soil is easily determined and is reasonably stable. But the individual constituents as chemical compounds fluctuate from day to day. These fluctuations are partly understood and are partly under control.

It is generally believed by those who are not professionally acquainted with the subject, that it is possible to determine by chemical analysis of the soil what fertilizers, and how much of each, can profitably be applied to it. This is sometimes the case, but it is a rare one. Soil analysis may reveal such scarcity of nitrogen, or potash, or phosphorus that one may safely conclude without any other evidence, that one of these substances will produce such results as are sure to be profitable. Much more commonly this is not the case. The soil analysis is likely to indicate what experimental tests are most likely to be worth while, and these experimental tests will then be a guide to the use of fertilizers on the farm.

There are many reasons why the analysis alone is not a safe guide for the application of fertilizers. It has already been mentioned that the elements in the soil are constantly rearranging themselves. What is present in the soil is of value to the farmer only as his crops take it up and use it. The crops take all of their food from the soil in solution in water. Any compound in

the soil is available when it is dissolved and unavailable when it is not dissolved. The extent to which the food materials in the soil enter into solution depends obviously on the amount of water present. In the soil of most farms and of the best coconut plantations there is moving water which brings into the soil about the trees food material from other places. However poor chemical analysis may show such soil to be, the trees are well nourished, and the use of fertilizers is very likely to be unprofitable. The application of fertilizers, guided by chemical analysis, but without taking into account the water supply of the soil, is, therefore, irrational.

Crops differ considerably in the demands which they make upon the soil. Some of them have deep root systems, and can accordingly take up food at depths down even as far as two meters. Others have the roots very close to the surface; for those deep seated stores of food are available only as the substances come toward the surface of the soil in solution. Some plants are conspicuous for the quantity of single food element which they require. These peculiarities of individual plants are always taken into account in applying fertilizers to crops of temperate lands. In the tropics it is customary to attempt this; but as a matter of fact our knowledge of the requirements of most of the staple tropical crops is altogether inadequate in this respect. We have no such analyses, that is, no such large number of analyses, of coconut trees, of their leaves, or nuts, or of the abaca plant or fibre, that any man can say with confidence that either of these plants need to take up any particular amount or any particular per cent. of any single mineral food. It is sometimes possible by analysis of the plant, or the marketable product of the plant of various temperate crops, to ascertain that some mineral food is not present in normal amount, and, therefore, to decide that this food could be profitably applied as a fertilizer. The knowledge obtained by analysis of the plant is in such cases a very much safer guide to the use of fertilizers than is the suggestion afforded by chemical analysis of the soil.

The second objection to the evidence at hand demanding the use of fertilizers on our crops is the fact that there is not sufficient account taken of the extreme variability of local conditions. The world's study of fertilizers has been made in Europe and the United States. In the central United States observations made in one spot are usually valid ten miles away, often one hundred miles away, or even more. The soils and climate have been so perfectly studied that the intelligent farmer can easily know whether or not the results obtained at his state experiment station are immediately applicable to his own farm. In the Philippines there is an astounding local diversity of soil. At this College it is difficult to secure a square tract of one hectare on which soil conditions are so uniform that one part furnishes a valid check for all others. The variable climatic factor is water. Its variations are not so intensely local as those of the soil except as the water varies with the difference in the soil. Still, there are places in the Philippines where at sea level the rainfall at points 20 kilometers apart varies in the ratio of fully 3 to 1.

Under such conditions the individual planter should take experience in other places as a guide to experiments, but cannot without risk take it as a guide to practice on a large scale.

With all this, I do not intend to discourage the use of fertilizers. Their proper use would be one of the greatest possible improvements in the

agriculture of most parts of these islands. There are provinces in which the staple industry will be improved by their judicious use more than in any other way. There are probably few farmers in the whole Archipelago who could not increase their profits if they know how to use fertilizers to the best advantage. But while they do not know what fertilizers are most needed, what forms can best be secured, when and how they should be applied, and what results can reasonably be expected from their use, the time for their widespread application has not arrived. Their use on a large scale, with confident expectation of profit, would merely result in the majority of cases in disappointment, and in the establishment of prejudices, which would be very difficult to remove, against their further employment.

In securing the adoption of any improvement in agriculture, haste must be made slowly. This is true when those who give advice are sure of their ground. When experimentation itself has not passed the earlier stages, it is not time to make haste at all. The time is always here to encourage the farmer to experiment, understanding when he does this that he is making experiments, and that it is not in the nature of an experiment that the result should be known in advance. He can be told with confidence that it is possible for him to use fertilizers with profit. He can also be told how to find out how to do this. In many places it is now possible for the government, through field representatives of its bureaux, to help the farmer plan his experiment, so that it will be most likely to show how to use fertilizers profitably.

The most rapid possible advance in the use of fertilizers in these islands will be by enrolling the farmers as experimenters, by helping them to institute and properly control their experiments, and by taking care that they understand that failure with one fertilizer and in one place is no more reason for discouragement than success with another fertilizer and in another place is a reason for the general adoption of locally successful methods.

Finally, it must be understood that many experiments prove nothing whatever, and that this is especially true of experiments made by those who are not especially expert in such work. So long ago that every individual concerned has now left the Philippines, I saw an experiment made on the fertilization of the coconut by means of ashes. These ashes were applied to two parallel rows of trees running east and west. During the succeeding few months the trees of the south row, which had received the ashes, exceeded the other row remarkably in production. This fact was duly reported as a most instructive demonstration of the value of ashes as coconut fertilizers.

The fact was that the trees of the south row were an average of 3 or 4 meters higher than those of the north row, and that they were at all times correspondingly thriftier. The experiment included the winter months when the south row shaded the north one to a considerable extent. But if the experiment had been properly started, the trees of the two rows exactly alike and equally exposed to all outside conditions except the fertilizers, it would still have been true that the application of the fertilizers could have had no appreciable effect on the production during the time the experiment lasted.

There have been reported to me the results of two other experiments on the fertilization of coconut in these islands. In both cases, the supposed improvement was observed before it possibly could have been due to the

fertilizers applied. In all of these cases the treatment was probably beneficial so that good happened to result from the accident; but the observed results were none the less accidental.

Men are not so quick to tell about their mistakes as about their successes, and it is probable that at various times fertilizers have been applied and decided to be valueless or injurious; and that the subsequent thrifty growth and production, for which the fertilizers were really responsible, have been construed as evidence of recovery.

The first essential in any scientific agriculture is the understanding of the ways of the plant.—E. B. C. in The Philippine Agriculturist and Forester.

SOIL FERTILITY PROBLEMS.

In reviewing the Rothamsted report for 1914, The Gardeners' Chronicle refers to some of its more salient points. e.g., the investigations into the importance of the liquid and gaseous concomitants of the soil. Until we know the state in which water exists in the soil, fertility cannot be said to be even remotely under control and the influence of manures on crops cannot be estimated with any degree of certainty. According to the Rothamsted investigations though the air in the soil is rarely in default the carbonic acid gas is sometimes very high and under the circumstances produces a deleterious effect on the growth of roots. Hence if fertility is to be controlled the nature of the free and dissolved gases, and the nature of the processes which yield these gases must be determined.

Another point which has been elucidated is that lime and chalk (carbonate) are not of equal value, for lime not only supplies calcium but exercises a partially sterilising effect, which chalk does not.

INFLUENCE OF SALT.

When salt is added to the soil, it may act in various ways upon the crops. As regards its injurious action, when in excess it tends to form with the soil particles impermeable crusts, which interfere with the aeration of the soil. In addition, it raises the osmotic concentration of the soil moisture, and so tends to make the soil physiologically dry to the plant roots, even while it still contains a fair percentage of free moisture. This effect is naturally more pronounced with freely transpiring plants than with drought-resistant ones. These two injurious actions will be feeble when the rainfall is abundant, but pronounced when it is scanty. As regards its beneficial effect, a solution of common salt increases the solubility of many of the mineral constituents present in the soil. Further, although salt itself is not generally considered to be a food substance to plants, it is always present in the ash, and since it is capable of influencing certain oxidase actions it may also affect the respiration and growth of the plant.—Journal of the Board of Agriculture.

THE EVAPORATION OF WATER FROM SOIL.

B. A. KEEN.

The relation between soil and evaporation was studied by measuring the rate of evaporation from moist soil maintained at constant temperature over concentrated sulphuric acid. An apparatus was fitted up by means of which it was possible to make successive weighings without removing the evaporating dishes from the sulphuric acid chambers, and thus to reduce very considerably the experimental error

Two solid fractions, fine sand (0·2—0·04 mm.) and silt (0·04—0·01 mm.), a sample of pure china clay and two soils were used in the experiments and when the rates of evaporation were plotted, curves were obtained which were continuous over the whole range, showing that there was no abrupt change in the physical state of the water between the limits experimented upon (i.e., from about 25 per cent. of water to dryness).

When a tray of moist sand or silt was suspended over sulphuric acid, the rate of evaporation was largely determined by the rate of diffusion of the water vapour from the sand to the acid, and the observed results agreed closely with those calculated from the laws of diffusion But soil behaved differently, the process of evaporation being so influenced that the comparatively simple laws holding in the case of sand or silt no longer applied. The soluble humus was then removed from a sample of soil by means of a 2 per cent. caustic soda solution, but the soil still behaved as before; ignition, however, completely altered the character of the evaporation which became precisely similar to the evaporation from sand or silt. Ignition on the other hand did not affect the behaviour of sand or silt, so that the difference between ignited and unignited soil cannot be ascribed to loss of organic matter, but should rather be attributed to the destruction of the colloidal properties of the soil. Further confirmation of this view was obtained by experiments on the china clay sample, which possessed only very feeble colloidal properties and yielded an evaporation curve practically identical with that given by fine sand.

Further information on the process of evaporation was obtained by a mathematical examination of the rate curves for soil. Two factors have been distinguished which operate over practically the whole range of water content dealt with in these experiments. In the first place the simple linear relationship observed with sand is not seen with soil, the curve being more nearly exponential in character, and indicating that the relationship of water to soil is quite different from its relationship to sand, a circumstance which has already been traced to the colloids. This relationship has only been expressed empirically, but it is probably connected with the relation between vapour pressure and moisture content. As the curve is not of a simple exponential type another factor must also be at work, i.e., the effect of evaporation of the decreasing water surface in the soil, the surface obviously diminishing as evaporation continues.—Monthly Bulletin.

VALUE OF SOIL ANALYSIS.

E. J. RUSSELL, D.Sc.

Analysis is the method adopted by the expert adviser for obtaining certain information about a soil. It includes chemical, physical and bacteriological investigations, and it may be accompanied by more general field observations for the purpose of discovering the nature of the subsoil, of the water supply, and of the climatic and other conditions important for the growth of plants.

A full investigation of this kind is found to be too laborious for ordinary use, and in practice shorter methods are commonly necessary. These do not aim at giving a complete account of the soil, but they express the amounts of certain substances present which are known to have an important effect on crop production. Experience has shown, however, that these methods are at their best when used for purposes of comparison, and as far as possible they should only be applied in this way. The analysis of a casual sample of soil from a district of which the analyst has no intimate knowledge is a much more difficult affair, and is often unsatisfactory both to him and to the farmer. Indeed, from the farmer's point of view, the question as to whether a soil analysis is worth conducting depends very largely on the possibility of making a comparison with some similar soil about which definite knowledge has been obtained by field experiments.

Fortunately, this country is now provided with organised schemes under which such systematic field experiments may be made and the results recorded ; the possibility of setting up comparisons is therefore steadily increasing.

HOW A SOIL ANALYSIS MAY BE USEFUL.

In at least three distinct cases useful help can be given by the soil expert :—

(1) The simplest case arises when a farmer wants to know whether he has any reasonable chance of obtaining results similar to those demonstrated by field experiments on another farm in his locality. Where, for instance, such experiments have demonstrated the advantage of applying lime, phosphates, or potash, the expert can with considerable accuracy say whether similar results can be obtained on the farm in question. He cannot be absolutely certain, as there is always an unknown factor, but the chances are that he comes out right. There is no doubt that much more use might be made of field experiments in this way with considerable gain both to farmers and the officers advising them.

(2) Another comparatively simple case arises when a farmer wishes to adopt some system of cropping or soil treatment known to give good results elsewhere in the locality, but before embarking on the charge he desires to know how far his soil conditions resemble those where the method works well. Here examination may reveal some difference which, while not very obvious to casual inspection, is of vital importance to the success of the enterprise. Two heavy soils, for instance, may look very much alike, but one may owe its heaviness to very fine particles and the other to silt particles. Methods that succeed in one case have often failed in the other, If the farmer is aware of the difference he can make his plans accordingly.

(3) The problem is rather more extensive when a man is entering on a new farm and wants to obtain as complete information as possible about the soil. Here the farmer must remember that no one person can possibly give him all the information that could be gleaned ; chemists, bacteriologists, physicists, could each say a good deal without exhausting the subject. A selection has to be made, and much time is saved where an interview can be arranged on the spot with the expert consulted, who can then ascertain exactly what information is wanted. Most farmers feel that they have a bent for some special branch of production, and they naturally wish to exercise their powers in the right direction.

On the other hand, many soils have some special feature fitting them for some particular crops better than for others. A certain amount of accommodation is possible on both sides. The farmer may alter both his scheme and his soil, and the best results cannot be obtained till the process is complete and the scheme made to fit the possibilities of the soil. This end may be and often is attained by the costly and bitter method of experience ; it can, however, often be reached more quickly by securing the services of the expert. In the first place an investigation will show whether the soil and the general conditions resemble those obtaining where the proposed system of husbandry is known to be a success. It may reveal the more important differences and enable the farmer and the expert to discuss methods by which they may be overcome. Secondly, a comparison of the results with others obtained in the locality will show the expert to what type the soil belongs, and he can then inform the farmer what systems of farming are known to succeed on this type. Thus the materials for a comparison can be got together. Although no one would pretend that anything like complete information could be obtained in this way it is certain that money and valuable time can often be saved.

DIFFICULTIES.

The problem becomes much more difficult directly the soil expert gets away from comparisons and is asked to make an absolute pronouncement on a sample of soil considered by itself. Of course, if he has considerable local knowledge, or if a soil survey of the district has been made, he may discover a standard of comparison, and then matters proceed tolerably smoothly. Failing this, he feels that his ground is very uncertain ; he has to try and put some absolute value on the quantities obtained by analysis and in interpreting the results a good deal of balancing of probabilities becomes necessary ; this is always a delicate business and is likely enough to miscarry.

Still more difficult is the case when the farmer does not ask for definite information on specific points, but puts the general (and natural) question. How can I manure my land at greater profit than I am getting at present ? Although every farmer must ask himself this question he will, after careful thought, quickly realise that it is much too complex to be answered off-hand. The analyst may be able to report that similar soils under similar conditions have given satisfactory returns for the application of certain manures to certain crops ; but the question whether equal returns would be satisfactory on the farm in question depends on many other factors—the amount of

capital available, the market facilities, the general economy of the whole farm, etc.—and a satisfactory answer can usually only be obtained when the whole question has been discussed by the farmer, the agricultural expert and the soil expert. Short of this, the best method is for the analyst to suggest two or three systems of manuring, and for the farmer to give them as good a trial as possible before making the final selection. This problem, of course, becomes more and more easy as the number of analyses is multiplied, but it continues to be very difficult until the expert's work is well organised.

CONCLUSIONS.

The farmer who wishes to derive the maximum assistance from soil analysis must bear the following points in mind :—

(1) The simplest problem for the expert is to compare soils, and, therefore the chances of success are greatest when a soil survey has been made or when some similar soil has been under proper field experiments.

(2) The object of the analysis is to furnish information, but no one has the time, even if he had the power, to set out all that can be discovered about a particular sample of soil. The farmer must, therefore, arrange to go over the land with the expert and discuss on the spot the various points on which information is desired ; the necessary samples can then be drawn with the proper tools and with all due precautions.

(3) Finally, it should be remembered that the problem is very difficult indeed when no satisfactory standards exist, and where the expert has not made a personal inspection ; so much balancing of probabilities has to be done that no expert can give more than a general opinion or do more than submit two or three alternative schemes for consideration and trial.—Journal of the Board of Agriculture.

SOME SOIL INVESTIGATIONS.

The effects of heat were studied on twelve different soils of varying types, the soils being heated to 100° and 250° C and to ignition. On the whole the effect of applying heat to soils was to render plant food compounds and other chemical compounds more soluble. The most important effects of heating soils are apparently included in the processes of flocculation, oxidation, double decomposition, and alteration of soil elements. There was a slight loss of total nitrogen from heating. One of the striking effects was the unusually rapid formation of ammonia after the soil had been heated. Heating soils seems to bring about rapidly the effects which are otherwise obtained more slowly by aeration. It has been noted in the case of all plants with which experiments have been made that growth is much more rapid on heated than on unheated soils.

Further experiments on the fertilization of rice substantiated the results already obtained along this line. In nearly all of the rice soils of Hawaii ammonium sulphate or some form of organic nitrogen seems to be the fertilizer most needed. Poor growth results from the use of nitrate as a source of nitrogen for rice. Experiments to determine the possible effect of aeration of the soil between rice crops indicated some advantage from aeration, but the experiments were inconclusive on account of the lack of soil uniformity in the experimental plots.

The investigation of the nature of nitrogen compounds in the soil has been continued and the subject studied from various standpoints. The results thus far obtained indicate that bacteria cause more rapid decomposition of the di-amino acids than of the other groups present in protein. A further study of this subject is being made on pure proteins. The hydrolytic and other decomposition products of proteins will receive further study.

Attention has been devoted also to a study of the physical properties of soils, with interesting results. In heavy clay soils all fertilizers used alone or in mixtures at the ordinary rate have been found to check the movement of soil moisture. Sodium nitrate increased the water-holding power of soils and also increased the rate of percolation of the water. Corresponding with this there was a diminution of the capillary rise of moisture. Capillarity was found to be greatest in silty soils, less in sandy soils, and least in heavy clay soils. In all these experiments the increase in the concentration of the fertilizer salts caused a diminution in the capillary movement of water. In ordinary soils all fertilizers diminished the percolation of water through the soils. Lime and magnesia salts check percolation less than the salts of sodium, potassium, and ammonium. In clay soils chlorides were found to check the flow of water less than sulphates, while the reverse proved to be true in the case of organic soils. In each case the soil which showed greatest capillarity offered the greatest resistance to the percolation of water. It was demonstrated that fertilizers exert physical effects which are perhaps more easily detected and measured than are chemical effects.

In a study of the function of fertilizers in soils it was found that phosphoric acid was fixed to a greater extent than other fertilizers. This fertilizer proved most effective when applied in the most soluble form. While, however, phosphoric acid in soluble form was fixed in the soil to an almost indefinite extent in so far as leaching is concerned, it still remained available to plants, as shown by the decided residual effect of phosphoric acid upon three successive crops grown without additional application of phosphoric acid. Ammonia was fixed to a greater extent than potash, but was less firmly held by the soil, and may become available more promptly. Nitrates were not fixed by Hawaiian soils to any appreciable extent. It was found that there was less loss by fixation in the soils when fertilizers were applied singly than when applied in combination. More deflocculation took place, however, when fertilizers were applied singly.

Continued study of the lime-magnesia ratio in Hawaiian soils brought additional evidence that this ratio is not important in itself. It becomes important only when soluble salts are in great excess or when the soil solution is greatly concentrated and the mineral matters out of normal proportion.

Additional evidence has been accumulated that attention to aeration is especially necessary for the proper growth of plants in Hawaiian soils. No nitrification took place without aeration. In soils which have been left fallow for a year or more there was practically no nitrate nitrogen, but nitrification took place rapidly as soon as the soils were thoroughly tilled.

Volatile antiseptics and heat were found to increase ammonification for a period of two weeks. Nitrification then began after about three weeks, and gradually increased to a maximum. Volatile antiseptics in experiments at the station did not kill protozoa, but these organisms were easily killed by

heat. The evidence accumulated in soil work at the station is against the possibility of protozoa being connected with nitrification in soils.

Continued pot experiments with various forms of phosphate have demonstrated anew that soluble phosphates do not leach through the soils, but remain permanently available for plant growth. It was also shown that legumes used as green manure greatly increased the availability of rock phosphate.

Analyses were made of all the common tropical fruits in Hawaii. A special study was made of the changes which take place during the ripening of bananas and papayas. A study was also made of the organic phosphorus of rice. This is of particular importance on account of the extensive use of rice as food. The organic phosphorus compound was found to be formed chiefly in the bran or outer layer of the rice grain.—REPORT OF THE HAWAII AGRIC. EXPT. STN. 1914.

THE MANURE HEAP.

As evidence of the loss which manure suffers when left freely exposed to the air and rain, the following figures, published by the West of Scotland Agricultural College,* are of interest:—

The respective losses in 4½ months in large (8-ton) heaps of freshly made cow manure were as follows :—

Nitrogen in open, 28·4 per cent.; under cover, 20·4 per cent.

Phosphoric acid in open. 21·1 per cent.; under cover, nil.

Potash in open, 28·3 per cent.; under cover, nil.

It was found, moreover, that the loss in manures stored in the open may amount in a few months to one-fifth of the total weight, but that this loss is reduced very considerably when peatmoss litter is used instead of straw. In the above cited experiment the relative manurial value of the open and covered-stored manures was tested on crops of potatoes and turnips, and it was shown by the crop yield that the manure stored under cover gave an increased yield of 7 per cent. over that from manure kept in the open.

Experiments conducted with the view of ascertaining the best means of conserving the plant-food materials in manure led to the recommendation that the liquid manure should be collected in tanks, i.e., separated so far as possible from the solid matter, that protection from rain should be provided, and that the manure should be trampled and covered with a 3-inch layer of soil. Thereby the loss of nitrogen is reduced to a minimum. The worst method is to leave the manure in a loosely packed heap, for in that condition fermentation proceeds rapidly and much nitrogen is lost in the form of ammonia.

Striking results were obtained in trials designed to ascertain the best time for distributing manure on the land. Fresh manure, 20 tons per acre, broadcasted on the land in autumn gave an increased yield, over unmanured land, of 25 per cent.; but equal lots of fresh manure stored till spring and the residue applied in drills to the same root crops (potatoes and turnips) produced an increase of 56 per cent.—GARDENERS' CHRONICLE.

* BULLETIN No. 65.

APICULTURE & POULTRY.

BEE-KEEPING IN THE WEST INDIES.

Of the two or three insects which are reared and kept by man for the economic value of their products., the bee and silkworm are the most important. The agricultural entomologist has usually to deal with this immense division of the animal world as pests, foes to be combated or eradicated if possible. Bees are certainly the most widely cultivated of these economic insects ; some species or other being valued throughout the world for their productions, honey and wax.

Some fourteen or fifteen years ago considerable interest seemed to have been aroused in the smaller West Indian islands in bee-keeping, owing to the efforts of the Imperial Department of Agriculture. A bee expert, Mr. W. K. Morrison, under the auspices of the department, visited all the islands of the Windward and Leeward Governments, and also Barbados, and gave lectures and instructions in bee-keeping, the substance of which was afterwards published as Pamphlet No. 9. This interest has largely diminished of late years except in St. Lucia ; perhaps because it was soon seen that bee-keeping in the West Indies could hardly be depended upon alone as a means of livelihood.

It would seem, however, that bee-keeping is admirably adapted for adding to the income of any one who has a little time to spare to give the necessary attention to it. In fact, it involves so little labour that in many parts of the world, notably in Jamaica, ladies are largely interested in it, to the benefit not only of their pockets, but also of their health and their mental powers. The value of the export of honey and wax from Jamaica is over £15,000 per annum.

To be a successful bee-keeper, whether with one or in hundreds of hives, it is necessary to study and observe their ways, and such study must greatly assist to foster the habit of taking notice of all sorts of other things in the world of life, animal and vegetable. Bee-keeping also calls for being out-of-doors, though not in the heat of the sun—a most healthy manner of life.

Apart from the intrinsic value of the honey and wax produced by them, bees are very valuable assistants to growers of crops, the yield of which depends on the fertilization of the flowers for the production of fruit. Hives of bees kept among lime trees or in orange groves help to secure a large yield, because by the visits of the bees a larger number of flowers are fertilized and set in fruit. The same rule probably applies to all tropical fruit, notably avocado pears and mangoes. Very likely larger bunches of coconuts are induced also by the visits of bees, which can be observed as constant visitors to the newly-opened flowers of this palm. In temperate climates it is well known that the visits of bees to leguminous plants are most beneficial, if not indispensable, to secure a large crop. An interesting point for observation, in case of bean crops being tried in the West Indies, would be the effect of

keeping bees within reach of them. As to the food supply for the bees from other than cultivated plants, the West Indies afford an inexhaustible supply of nectariferous flowers, from the unrivalled logwood to the otherwise poisonous manchineel.

Considering the attention that is being paid at present to encouraging new food-producing industries in these islands, it may be worth while to draw attention to this, if only as a by-production. Although not very remunerative, honey and wax do pay the patient, careful, and observant bee-keeper, as is proved in Jamaica and in St. Lucia, to a minor extent, where the industry is growing. There is always likely to be a sale for honey of good quality, if produced in marketable quantities, in larger countries. Quite lately enquiries have been made from Canada as to the possible supply of honey from these islands, and encouragement given as to the ready sale of it there.

Anyone who wishes to try bee-keeping for any of the reasons mentioned above, even by beginning with one hive or two—and that is enough for the beginner—ought first of all to get some knowledge of the subject, which Pamphlet No. 9 of the Pamphlet Series of the Agricultural Department will give.—The Agricultural News.

POULTRY HOUSES AND APPLIANCES.

In building a poultry house the following important points should be observed :—

(1). With regard to material the timber should be sound and dry. The cost of deals is largely governed by the extent to which they have been seasoned. If newly cut there will be shrinkage and warping as the natural moisture evaporates It is, therefore, true economy to pay, say, 10 or 15 per cent. more for thoroughly seasoned wood.

(2). Narrow deals are cheaper than broad ones.

(3). Deals are sold by timber merchants by the square, that is, with a surface of 100 sq. feet.; scantling for frame-work and joists is sold per 100 ft. run.

(4). In regard to construction the back, two sides and roof of the house should be solid, and air and water-tight. For this purpose well-seasoned, tongued and grooved deals are preferable, if tightly clamped together. These should be fixed to the frame perpendicularly. If fixed horizontally special deals must be used, each overlapping that below. These are more expensive, having to be specially cut, and a larger amount of timber is required.

(5). Ventilation must be adequate. It is best secured by making the house, which should always be the maximum height in front, what is called "open-fronted," that is, a space 15 to 30 in. above the floor should be boarded and the rest covered with wire netting. This ensures a constant circulation of air without draught. The inmates are quite comfortable even on the coldest night, and the air is not at such times saturated with moisture, which is the case if ventilation is insufficient. To prevent rain driving in, a sloping or sliding shutter should be fixed outside. Open-fronted houses do not

usually need windows, as the lighting is abundant. Sunlight purifies th atmosphere and kills many forms of organisms.

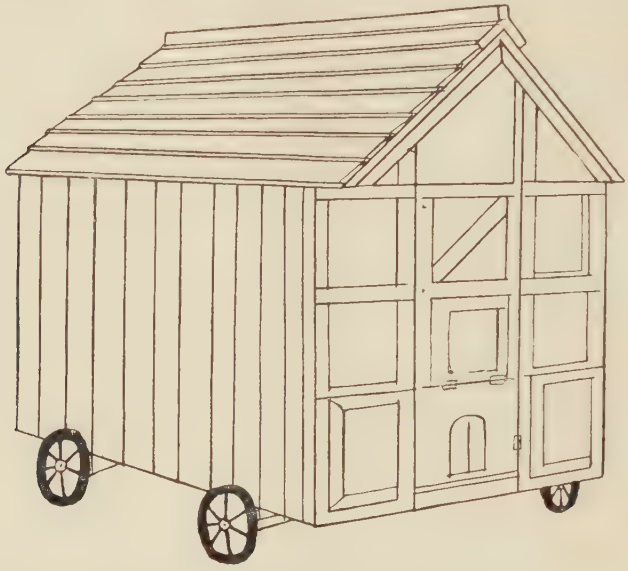

Fig. 1.—Field House for 20 Birds.

(6). The internal fittings should be as simple as possible, and capable of easy and immediate removal. Perches may be made of 2 in. by 2 in. scantling with corners smoothed off, resting on supports fixed to the sides, 15 in. to 2 ft. above the ground in portable houses, or 3 ft. above the ground in fixed houses with, in the latter case, a dropping board below in order to give a greater amount of scratching space. Nest boxes in portable houses should be raised 12 in., and one compartment should be allowed for every four or five hens. With a little alteration orange boxes are excellent for this purpose.

(7). Cleanliness is supremely important. The whole house—roof, walls and floors—should be regularly brushed over; nesting materials should be renewed frequently; and lime washing or spraying with a good disinfectant twice a year is essential.

Types of Houses Suitable for Allotments and Gardens.

On the larger allotments or small holdings, that is, such as approach five acres in area, where the fowls are not kept within enclosures of wire netting and have, therefore, a measure of liberty, what is known as a portable or field house should be employed, either upon wheels or upon runners, so that it can be removed frequently in accordance with methods of cultivation, or to prevent injury to the grass. Figure I illustrates a suitable type of such a house.

What is known as the Colony System can be recommended upon allotments ; that is, one-fourth the ground available is devoted entirely to the fowls for a year. It is enclosed by wire netting, which is removed bodily to enclose another similar area, the process being repeated annually, and forming a four-course rotation. Under such conditions, especially if the enclosed areas do not exceed an acre, a scratching shed house is desirable to afford

abundance of shelter and provide exercise, the grain being scattered among litter on the floor. On larger areas, especially if the land is arable, a scratching shed is not required.

On garden plots, and where by reason of the limited amount of land available the runs must be small, the scratching shed system is also advised, the size of house being varied with the number of inmates. Upon garden plots and where land is very limited double runs should always be used.

Specification of Apex Portable Poultry House.

In houses which must be moved frequently it is essential that the frame should be strong to stand the strain, or it may soon come to pieces. The joints should, in all cases, be tightly mortised, and where cross stays are used the ends should be cut and fitted into corresponding grooves in the uprights, as nailing does not afford sufficient resistance to the strain.

An apex house on similar lines to that illustrated in Fig. 2 may be 5 ft. wide, 6 ft. long, and 6 ft. high to the point of the gable, with side walls $1\frac{1}{4}$ ft. high, and boarding in front $1\frac{3}{4}$ ft. high. The capacity is 15 adult fowls, or 20 growing chickens. Roof, sides and back are solid, except that a door is made

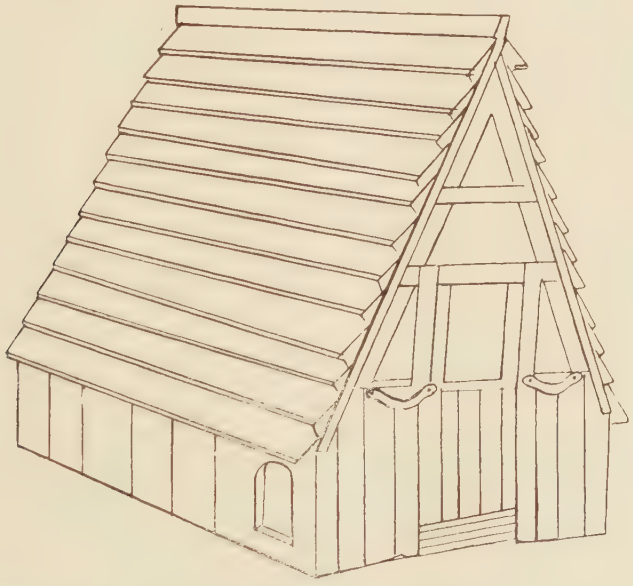

Fig. 2.—Apex House for 15 Birds.

in the last-named. The front consists of boarding $1\frac{1}{4}$ ft. from the ground, with 1 in. mesh wire netting above, and a triangular shutter. The roof may usefully be carried a foot beyond the front.

Material Used.

Scantling for frame, 2 in. by 2 in.; to reduce weight, 2 in. by $1\frac{1}{2}$ in. may be used, but the heavier material should be used for the sills or bottom frame. Boarding, white deals, 5 in. by $\frac{3}{4}$ in., tongued and grooved. Wire netting for front, 1 in. mesh. One pair of 9-in. hinges and lock or catch for door; a supply of $1\frac{1}{2}$, 2 and $2\frac{1}{2}$ in. French nails ; optional, guttering and felting for roof.

FRAME.

Front: 2 lengths, 5 ft. each, for sill and cross; 2 lengths, 6 ft., for roof; 2 uprights from roof stays to sill, 1 ft. 3 in. each; 1 cross tie, 2 ft., below apex. Back: 1 length, 5 ft., for sill; 2 lengths, 6 ft., for roof; 2 uprights, 1 ft. 3 in.; 1 cross tie above door; 2 uprights, 4 ft. 6 in., for door space. Roof: 3 lengths, 6 ft. 6 in. Sides: 4 lengths, 6 ft. Floor: 1 length crosswise 3 ft. from each end, 5 ft. Two perches, each 5 ft. long, will be required. The total is 116½ foot run.

Match boarding should be firmly nailed upon the frame. Allowance has been made for the roof to project 3 in. at either end, but a projection of a foot at the front end is better. The timber required will be as follows:—Front, boarded 21 in. up, 8¾ sq. ft.; back, inclusive of door and cross pieces of the same material, 21¾ sq. ft.; sides, 15 sq. ft.; roof, 78 sq. ft.; and floor, 30 sq. ft.; total, 153½ sq. ft., or, with allowance of 24 sq. ft. for nest boxes, 177½ sq. ft. in all.

To prevent the entrance of rain at the apex of the roof a cap should be made, planed and carefully jointed, from 6 ft. by 6 in. boarding cut down the centre; or iron guttering can be bought cheaply and fitted upside down; or if the roof is covered with felting, one length may be nailed over the apex.

Where the door is placed at the back it must fit tightly to prevent draughts; otherwise it would be better to make the front into a door, either wholly or partly. An excellent plan is to nail a strip of wood outside all-around the door, overlapping 1½ to 2 in. on to the wall against which it closes.

If the house has to be moved frequently wheels should be attached. In this case 3 × 3 in. wooden beams should be bolted right across the under frames of the house a foot from either end, to which the axles are attached, or stout iron axles 6 ft. long may be employed. The wheels should be not less than 9 in. in diameter with a 2 in. tyre. An alternative is to use runners fixed lengthways with ends curved upward. These should not be less than 6 in. broad. A horse is required for removal where runners are employed.

The two perches should be fixed at the back 15 in. above the floor and 18 in. apart.

The nest boxes should be removable, 15 in. square, 12 in. high, and without bottoms, standing upon the floor or upon the ground under the dropping board. If in sets the partitions and ends alone need be solid, as strips of wood back and front keep them firm.

Thorough creosoting or tarring outside will preserve the wood, and tend to keep down parasites. It is an economy to cover the roof with felting.—

Board of Agric. and Fisheries Special Leaflet No. 11.

A new method of growing maize is recommended by the U.S.A. Department of Agriculture for arid areas. While the rows are placed twice the usual distance, the seeds are sown twice as thickly in the rows. The object is to make the most of the soil moisture. In West Kansas the new system was found to raise the yield to nearly three times as much as is secured under the ordinary conditions of planting.

ENTOMOLOGY.

THE SHOT-HOLE BORER OF TEA.

At the meeting of the Committee of Agricultural Experiments held at Gangoruwa on May 13th last Mr. Speyer in continuation of an account of the life-history of the Shot-hole Borer of Tea, *Anisandrus fornicatus* Eichh., said that the investigation had advanced a step further. The female beetle, having completed the entrance gallery and the first spiral gallery, as referred to at the last meeting, deposits from 2 to 5 eggs in the second spiral—a gallery which is subject to infinite variation in length and direction, within proportional limits to the total extent of the whole gallery. This gallery completed and the eggs deposited, borings of a different nature from those of the previous borings are seen to be ejected through the entrance hole. When a small heap of borings has accumulated—each shred of the plant tissue being passed between the legs of each side to the posterior of the insect—the beetle pushes them out through the entrance gallery, finally protruding the extremity of the body out of the entrance hole, and thus always moving in the galleries in a backward direction when approaching the entrance from inside. These borings are the result of the tearing away of the pith of the stem, and mark the beginning of one or other of the longitudinal galleries—usually, however, the gallery which passes downwards through the pith of the stem.

The time which is expended in making the second spiral in which the eggs are laid, and the time which elapses before beginning of the first longitudinal pith gallery, is naturally dependent upon the rate of the maturating and of the development of the egg in the body of the beetle.

Should these periods be well advanced, then the egg gallery will be short; if backward, then the second spiral gallery will be long. In cases where the periods are abnormally extended the longitudinal gallery is constructed before the eggs are laid, and then there is some evidence (though at present quite inconclusive) to show that the eggs, perhaps 8 to 10 in number, are laid on the completion of the longitudinal gallery at the extremity of that gallery.

The process of oviposition does not stop here but is continued again after the whole gallery is constructed, but exact details as to this must be deferred till later.

It can be asserted, however, that from the beginning of the gallery up to the laying of the first mass of eggs, no male beetle enters the gallery.

Some peculiar and interesting, if not remarkable, observations have been made upon the growth of the fungus upon which the larva and adult beetles feed, and the rate of growth of this fungus no doubt occasions extensive variation in the time required for the construction of the various parts of the gallery. At present these variations must lie in obscurity.

Referring to the suggested control methods as applied to Shot-hole Borer, the fact that neither the larvæ, nor, as far as is known, the adult

beetles actually feed upon any part of the tea plant, leads to a question of some importance regarding the various suggestions which have been made concerning the use of sprays and chemical salts, either applied to the plant itself or to the soil around the plant, either with a view to preventing the entrance of the beetle into the plant, or to making the juices of the plant distasteful to the beetle.

The female beetle, in boring into the stem does not swallow the borings, but ejects them without their passing into any part of the alimentary tract.

A spray containing a chemical salt applied to the bushes, either pruned or unpruned, would make a film over the bark of the stem of extreme tenuity, so that in any place where the film was discontinuous—and there would be many places due to drying or crystallising—the beetle would bore in without the slightest difficulty.

Further, the method of spreading salts on the ground to render the tissues of the plant distasteful would be equally fruitless, for, in passing into the composition of the tea-plant, their composition would be completely altered during the metabolism of the tissues, in which they would be broken down and built up again in a different form.

The composition of the plant would then not be materially altered, and the structure of the wood remain unchanged altogether.

The beetle larvæ, which draw no nutriment from the plant, would therefore develop undisturbed, and there is no evidence to show that the growth of a fungus has, or will ever be, seriously affected by such treatment. Apart from this, there is urgent call for economy in any control scheme for Shot-hole Borer, and both the methods mentioned above would be costly past economy.

Further arguments on these points can be drawn from the *combating of other insect-pests.*

The extermination of the Gipsy-moth, in Massachusettes, U.S.A.—the caterpillar of which defoliates broad-leaved trees of all descriptions—has been ventured by more methods perhaps than in the case of any other insect.

Spray mixtures of lead arsenate—apart from the huge cost expended in the use of this substance —had a very minor effect, compared to more simple and quite recent methods, which have been arrived at by ordinary observations, upon the habits of the insect, namely that a caterpillar in its early stages is unable to feed upon the leaves of pine trees, and the placing of woods under proper forest conditions, by thinning, has had a marked effect upon the decrease of this pest over and above the methods mentioned, and the introduction of countless parasites from other parts of the world. It only remains to be added that wood-boring insects—known as internal feeders—such as the Leopard Moth of Europe and U.S.A., the Scolytid Beetles of Pines, and the Bupestrid Beetles of the latter country, have all been combated with sprays, and in other complex ways, without the slightest success.

Any insect-pest which has been eradicated, either wholly or partially, has been stamped out by simple methods arrived at by simple observation upon the habits of the insect, for the very reason that the balance of Nature and the relation of insect to host-plant helps the would-be exterminator at every turn.

The same is bound to apply, in the long run, to Shot-hole Borer, and as an illustration of observation work, it is proposed to present two methods, which have been adopted in the study of the insect, upon which the Committee are asked to pass judgment as to which has been most effective.

Contrasting the methods of experiment in Shot-hole Borer investigation, the incomplete account of the life-history already given, has been arrived at by fixing glass tubing over shot-holes in tea plants, and, to provide suitable ventilation, an apparatus has been devised with which this glass tubing communicates, thus preventing the escape of any emerging beetle or other material which may make its exit from the galleries.

Apart from the time expended in setting up the apparatus, and bending the glass tubes, this complex method of working can only be applied to a comparatively small number of individual beetles and galleries, so that little idea can be ascertained of the general entrance and emergence of the beetles from the galleries, which is the first piece of knowledge essential to the determination of any control schemes.

The second method adopted was the choosing of an area of plantation which contained 256 tea plants, of which 91 were or had been attacked on or before April 24th, and 145 had not been attacked on that date. Every branch attacked was cut out from its base on that date, and between May 4th and May 8th the trees were again examined—the previously attacked trees having been marked with sticks.

On May 8th, 78 trees had been attacked again, of which 20 had *not* been infested previously, and 58 had been infested before April 24th. The remaining 33 trees which had been attacked before April 24th were not attacked again. Some of the trees from which the shot-hole had been eradicated on April 24th had only one branch left—others only 3 or 4, so that the branch area of attack was considerably lessened, making the number of trees re-attacked still more prominent.

It is possible to draw the following direct conclusions from this simple experiment :—

1. An emergence of the beetle took place from the surrounding infested tea between April 24th and May 8th.
2. During the wet season there is considerable activity on the part of the insect.
3. Trees attacked once are highly liable to further attack.
4. An invasion of the beetle will infest trees not previously attacked.
5. To leave one branch on a tree unpruned—a suggestion which is current for the control of the Shot-hole Borer in the pruning season—courts the increase, rather than the decrease, of the beetle.*

MR. SPEYER said, in conclusion, that it must be emphasized that the extermination of Shot-hole Borer is a matter for urgent and pressing haste, lest those areas which are now uninfested become subject to attack, and the insect gets a still further grip upon a produce of vast importance.

The necessity of obtaining a clear idea of areas which are infested and most particularly those which are not, cannot be exaggerated, and the Members of the Committee of Agricultural Experiments are urged to do

* Since this account was given, these results have been confirmed, and other conclusions arrived at, which may be far-reaching in future investigations.

all in their power to further the registration of infested estates at a time when the Shot-hole Borer investigations may be said to have reached a critical period.

The CHAIRMAN thanked MR. SPEYER for his interesting remarks and a general discussion followed.

MR. WILKINS asked if the borer was found in many other plants and whether it infected jungle, because if so its control would be almost hopeless as most estates had jungle round them.

MR. SPEYER replied that owing to the habits of the beetle, it would only be found in dead wood of a few jungle plants, if in any. In the dead branches of living plants, as far as was known, it had been found in cocoa, grevillea, and dadap—especially the thorned species—and was reported in living crotalaria. It was doubtful whether it attacked healthy albizzia. He asked that specimens might be sent to him.

MR. W. SINCLAIR said he knew of an absolutely isolated estate infested with Shot-hole Borer and would like to know how it got there.

MR. SPEYER thought it might have been imported either in fire-wood or young plants ; also the female beetle was capable of flying considerable distances, but that it was essential to see such places himself before forming any opinions.

MR. GRAEME SINCLAIR asked whether it was possible that coolies could carry the beetle either on their clothes, in their rice or in manure sacks. This was popularly supposed to be the case, especially as the borer was generally bad on the sides of roads used by coolies.

MR. SPEYER thought it unlikely that beetles would be spread in such a manner, and that they would be distributed more easily by their own flight.

MR. COOMBE thought elevation had much to do with the spread of the pest and that above 4,500 feet it was practically unknown. It was very noticeable on estates, where the elevation rose from two to four thousand feet, how the tendency was for the pest to spread upwards.

Mr. WILKINS thought it was worse in districts where heavy rainfall was experienced.

MR. GOLLEDGE drew attention to the importance of protecting estates that were free of the pest, Kalutara District being practically free. He would like to know if any estate in Kalutara had been notified as being infected ?

The CHAIRMAN said he would find out. But the new regulations were so framed as to check the spread. There were already 400 estates registered, but doubtless many infected estates remained unregistered. Asked as to the penalty for not registering an infected estate, he said it was Rs. 1,000 fine or 12 months imprisonment, or both.

MR. HEW KENNEDY said the Planters' Association had circulated for a complete list of infected estates, but that many planters were in doubt with whom they should communicate, and also whether they were really infested or not. A staff was undoubtedly needed in order to investigate such cases and report estates—especially in the case of native tea-gardens—who

persisted in not registering and to see that infected estates rigorously kept the rule of not selling plants, stumps or seed. For instance he would like to know how he was to answer an estate which was not sure if it really had borer or not and wanted to sell plants. Was it to wait indefinitely till the point could be determined?

The Chairman replied that the regulations were quite clear on such a point—no estate under suspicion could sell plants without incurring the penalty. Mr. Graeme Sinclair asked if any opinion could be formed as to the ultimate success of the investigations?

The Chairman replied in the negative. The object in asking Mr. Speyer to speak at these meetings was that members might have some idea of what was being done and that in the discussions that followed opinions could be exchanged and useful information gathered. But it was too early to form any definite conclusions.

Mr. Coombe quite agreed and stated he was most satisfied with the results so far obtained and that he would continue to do all in his power to further the investigations.

NITROGEN FIXING BACTERIA IN LEAF NODULES.

Every year sees further advances made by Science in wresting from Nature her secrets in connection with plant life with results of far reaching practical importance.

The discovery regarding the functions of the bacteria inhabiting the tubercles found on the roots of certain plants has had a marked influence on the question of maintaining the fertility of the soil.

What is regarded as the most remarkable of recent discoveries is that referred to in the January number of the Botanical Gazette, viz. the symbiotic relationship between bacteria and seed plants as seen in certain *leaves*.

In 1894 Trimen (late Director of Peradeniya Gardens) drew attention to the small knob-like excrescences on the leaves of certain Ceylon Rubiaceæ e.g. *Pavetta indica* (S. Pawatta). In 1902 Zimmermann recognised the presence of bacteria in these structures. Subsequently the researches of Miehe and von Fabek revealed the fact that these bacteria were also nitrogen fixing organisms.

It is a noteworthy fact that among the Tamil cultivators of the North "pawatta" is in high esteem as a green leaf manure.

GENERAL.

SHADE TREES.

(*See Frontispiece.*)

The importance of shade trees in the tropics is impossible to over-estimate ; they are often essential to the planter for his crops, to the gardener for the growth of his more delicate plants, and are a boon to man and beast on account of the shelter they afford from the sun. Most crops in the tropics require shade at one stage or another, some more or less permanently, especially at low elevations. Bungalows or other human abodes are in many cases rendered cooler and pleasanter by the judicious planting of suitable trees in the vicinity, the green foliage absorbing a certain amount of the strong light and tempering the powerful rays of the tropical sun. The presence of certain kinds of trees has not only the effect of rendering the atmosphere cooler and healthier by checking excessive radiation from the soil, but may also be the means of reclaiming swampy land and eradicating malaria. Thus in towns as well as in malarial districts, the hygienic effects of suitable and well-grown trees is a matter of common knowledge.

All trees however are not equally suited to the purpose, and it is very important that in making a selection the greatest care and discrimination should be exercised. Trees which have adaptations for collecting water, as sheathing leaf-bases or a spathulated inflorescence, should not be planted near houses, for they harbour mosquitoes and thereby encourage malaria. Certain trees, as Spathodea, may also be a source of danger from their soft brittle character and liability to be blown down by wind ; while others (as species of Ficus) are objectionable and dangerous on account of their extensive root system. Others again, as Casuarina, frequently block gutterings, drains, etc., by the almost constant dropping of leaves.

QUALITIES OF GOOD SHADE TREES.

The suitability of trees for purpose of shade depends of course on local conditions and individual requirements ; those which would be suitable for public roads would not be satisfactory for street-planting, and vice versa. Some trees may, according to position, serve other useful purposes in addition to providing shade or shelter ; thus, certain kinds which yield edible fruit or other useful product may in some localities be also employed to combine shade. In parts of India, mango and other fruit-as well as lac-producing trees are utilised for this dual purpose; in some European countries the leasing of fruit-trees which have been planted along public roads is a valuable source of revenue to their respective governments. The most essential qualities of a good shade-tree are : (1) it should be ever-green, or at least have the habit of putting on fresh foliage immediately after shedding the old leaves ; (2) it should normally have a good spreading form, with an upright clean trunk for at least 10 feet from the ground ; (3) it should be a moderately fast grower ; and (4) the foliage should be of a light feathery nature, preferably consisting of small leaves which have the habit of closing up at night or in dull weather, as in the case of certain leguminous species. Those of slow rather than rapid growth are preferable, for too rapid a growth must be deprecated as being productive of brittle wood and short-lived trees. It may be noticed that trees in general belong to either of two types of habit of growth, viz.: (1) those in which the branches are developed in an upward or horizontal direction, and

(2) those with the branching system curving downwards or drooping. Trees of the former type are the most suitable for road-sides or streets, while those of the latter are very effective when planted in parks, pastures or open spaces. The merits of any tree may be said to depend largely upon the attention given it when young, as well as on the manner of planting. Careless or improper planting, injury by cattle, etc., when young, or ruthless treatment by disinterested owners of adjoining land, will permanently injure or disfigure trees however good their qualities.

TREES FOR PARKS, PASTURE LAND, ETC.

Here scenic effects must be studied in combination with the practical purpose of shade-trees. Those of bold appearance, with striking foliage and drooping branches, will produce an imposing effect and at the same time improve the conditions for pasture, their shade encouraging the growth of soft, tender herbage.

SHADE TREES FOR FIELD CROPS.

That suitable shade-trees, thinly planted and properly tended, have beneficial effects, physically or chemically, upon most crops in the tropics is an established fact. They help to conserve moisture, ærate the soil by means of their deep-feeding roots, which bring plant-food from the under-strata to be returned again in the form of mulch by the fallen leaves. Further they may be lopped during seasons when shade is least required, and the loppings used as a mulch for the crops. Leguminous trees are preferable for various reasons, viz.: (1) they are usually fast-growers, (2) their thin feathery foliage does not form too dense a shade, and (3) their leaves have often the habit of closing up at night, and (4) many of the family have the property of collecting free nitrogen by means of bacteria nodules on their rootlets.

TREES FOR ROADSIDES, STREETS, ETC.

Trees of the type with upright (not drooping) spreading branches should be chosen for this purpose. They should have a deep rather than a surface system of roots, and should not be of rapid growth, for this, as already stated, will not produce stable and shapely specimens. Large leaves and heavy dangerous fruits are obviously characters which disqualify for planting in public thoroughfares. The ideal tree for this purpose should have, in addition to being evergreen and of an upright spreading habit, light thin foliage, with the leaves closing up at night or in dull cloudy weather. The Inga Saman, or "Rain Tree," approaches these requirements very closely, but it has the disadvantage of growing to too great a size for streets, its surface system of enormous spreading roots being also dangerous in the vicinity of buildings. It is however an excellent tree for planting along rur l roads and is adapted to a wide range of climate ; incidentally, its nutritious sugary pods form an excellent cattle-food and are an article of export from South America.

RULES FOR THE PROPER PLANTING AND CARE OF SHADE TREES.

The planting and preservation of suitable shade trees for road-sides being of greatest importance to the public in general, the writer would suggest the adoption of certain recognised rules, such as the following, for their proper planting and maintenance :—

(a) Proper holes (from 2 to 3 feet deep, by as much in diameter, and $\frac{3}{4}$ filled with good soil) to be prepared before planting.

(b) Where possible, holes to be well behind the side-drains and not in the margin of the road : the distance from the road should be from 8 to 10 feet, according to circumstances.

(c) The plants to be well-established in bamboo-pots or plant-baskets before being planted out.

(d) Planting out should, as far as possible, be done at the commencement (not at the *end*, as is frequently the case) of the rainy season.

(e) The distances for planting apart in the first place may be from 20 to 30 feet (according to the species of tree), every alternate tree being cut out later, if necessary, as it fills its allotted space or encroaches on its neighbour.

(f) Proper protection must be provided, either collectively or individually, against cattle, etc., by means of tree-guards or fence until the trees are sufficiently established to take care of themselves.

(g) The injudicious cutting of branches or interference with the growth and proper form of trees in public thoroughfares, should be considered an act punishable by law.

(h) The building of houses, huts or shanties too close to the trees should be prohibited.

In a subsequent issue selections will be given of trees suited as shade for special purposes and different elevations.

H. F. M.

ONION CULTIVATION IN HAWAII.

The work of the Waipio substation is of a co-operative nature. The main problem for the year was a study of onion production. Red and white Bermuda onion seed was planted directly in drills in the fields on September 23, October 3, October 9, November 13, and December 10. Part of the seed was planted in shallow furrows and part in level culture. The Waipio substation is in a region of low rainfall, but unusually heavy rains occurred this year, filling the furrows with soil and burying the onion bulbs. Considerable thinning and transplanting had to be done throughout this area, and the bulbs buried by washed soil had to be uncovered. The best results were obtained from the sowings in September and October. November and December appear to be too late. Areas on which trash was burned not only produced larger onions, but the onions required only 90 to 100 days from seeding to maturity, as compared with 130 to 160 days on areas not burned. It is planned to carry on some experiments to determine whether it may be economical to heat the soil in the rows by means of a crude-oil blast before planting. The area planted to onions was 8 acres. Most of the soil shewed 3 per cent. manganese by analysis. From seeding to harvest 23 inches of rain fell. The eight acres of onions yielded 32,210 pounds, not counting the small onion of pickling size.—REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1914.

AGRICULTURAL PROGRESS IN INDIA.

The Report of the Agricultural Adviser to the Government of India for 1913-14 which has just come to hand reviews the progress of agriculture in India during that period.

The report opens with a sketch of the origin and development of the Research Institute and College at Pusa, which owes its present position to LORD CURZON, an excellent portrait of whom forms the frontispiece.

In the section devoted to Agricultural Bacteriology at Pusa reference is made to the examination of soils for azotobacter, and we read that the addition of a seer of cane sugar to a plot of 2 square yards increased the nitrogen contents of the first 6 inches of soil by 15 per cent. during 10 weeks. As many soil organisms produce soluble carbohydrates by their action upon the cellulose of buried organic residues, this stimulation of nitrogen activity may be found to be of considerable practical importance.

In the Bombay Presidency perhaps the most valuable work done was in increasing the water supply, chiefly by means of well-boring. The operations in Gujarat, during the past five years are said to have increased the available supply of water for the irrigation of crops by 900,000 gallons per hour, a result which is tending to turn this tract into one large garden.

In the Madras Presidency the development in the cultivation of green manure crops in rice fields is remarkable. In the District of Chingleput alone some 32,000 lb. of seeds of these crops were disposed of, and the Director thinks it impossible to estimate the ultimate demand when trained men are sent to popularise the practice of green manuring.

In the Bengal Presidency Mr. Annett, the Agricultural Chemist, who has been studying the enzymes in Indian seeds, has made the discovery (which may prove useful as a quantitative test for urea in urine or blood) that the swordbean contains a ferment which rapidly changes urea into an ammonium salt.

It is interesting to read that in the Punjab Mr. Cousins, lately an officer of the Military Department, has placed his large practical experience in bee-keeping at the disposal of amateur workers.

The extension of groundnut cultivation in India has been remarkable. In the Bombay Presidency the area under the crop has risen from 57,000 acres in 1903 to 181,000 acres in 1913. In the United Provinces where the crop was introduced 8 years ago it now covers about 35,000 acres; in Madras the increase has been from 393,100 in 1905-6 to 1,175,200 in 1913-14; in Burma from 80,000 in 1906-7 to 240,000 in 1913-14.

As regards coconuts we read that in Travancore coconuts yield more than 70 per cent. of the total customs revenue and that work is now being done in connection with the systematic manuring of the palm and the study of the characteristics of different varieties of the nut.

The following remarks by Mr. Keatinge, Director of Agriculture, Bombay, on the subject of dry-farming are worth reproducing:—

"Other points in which the dry farming regions of the United States of America have an advantage over us is that the rainfall is far more consistent and better distributed. They know fairly well what rain they can count on, and do not get such excessive downpours in a day as we often get. With us a tract which usually gets less than 15 inches of rain in the year may suddenly get 20 inches in two months, or contrariwise in a famine year a tract may get less than two inches in a year. Further the heat of the sun, and consequently evaporation, is far less in the United States of America, during the greater part of the year; and in the late summer when the heat there is considerable, the crops cover the ground. Last but not least must be mentioned the fact that they have at their disposal far better teams and far better implements than our farmers have.

"My general conclusions are:—

(1) That we must work our own problems of dry-farming.

(2) That the study of soil physics is a matter of great importance to us."

The report also contains an account of the All-India Agricultural Conference held at Coimbatore on December 8th, 1913, at which the Secretary of the Agricultural Society was present as a delegate from Ceylon.

THE EFFECT OF TRANSPLANTING UPON RICE PRODUCTION.

In the experimental field of the Rice-growing Station at Vercelli, systematic experiments have been carried out to ascertain the effect of transplanting upon rice production. The latter operation was effected in the same soil in which the sowing had taken place and from which were taken the seedlings for transplanting. Thus, in the case of one of the experimental varieties, Ranghino, the transplanting was effected in ground immediately adjoining the plot in which it had been sown and from which the seedlings for transplanting had been thinned out. The seedlings were moved early in June and planted (as is the rule) in tufts of 3 to 4 at a distance of 10 to 12 in. apart, the tufts being arranged in a quincunx.

After the usual period of taking root, the leaves grew luxuriantly and the plants were green until after the beginning of July, developing and tillering in a satisfactory manner. The same varieties of rice which lodged when grown where they had been sown, showed, in the transplanted plots, a noteworthy resistance, and it was only when nearly ripe that some of them, for instance Shiraighe and Jojiruschi, lodged, and then with little injury to their yield. The proportion of aborted grains was much less and the straw was stronger and hardier.

The numerical results given by the first experiment were as follows:—

Variety.	Yields in lb. per acre.	
	Untransplanted.	Transplanted.
Onsen	6,197	5,911
Shiraighe	3,137	4,983
Sckiyama	4,293	5,745
Takatzu	4,348	5,243
Jojirushi	2,620	6,610
Nero di Vialone	3,860	4,197
Lencino	5,247	4,100
Runghino	3,498	5,412

Only the Onsen and Lencino varieties gave inferior results; and it is noteworthy that, while the other untransplanted varieties suffered injury from lodging, these two, which seem not to bear moving, proved very resistant to lodging. The writer, who in continuing the experiments, considers that he has now proved that by transplanting, it is possible to maintain good crops, especially, in the case of those varieties of rice which have the weakest straw.—MONTHLY BULLETIN

The Agricultural Department of North Wales recommends the use of salt in place of potash when, as now, it is difficult to supply in manures, in view of the fact that it is able to liberate some of the potash locked up in the soils. For annual crops, such as potatoes, a dressing of 5 to 6 cwt. per acre is recommended to be broadcasted some weeks before planting. The salt must not be mixed with superphosphate.

BACK TO THE LAND.

WOMEN.

One of the results of the war is that a great number of women as well as men have been thrown out of work. In London alone no less than 40,000 women were put out of employment almost immediately war was declared. Unlike men, women could not, when the workshops were closed, go down to the recruiting centres and answer their country's call.

It was through the initiative of Her Majesty Queen Mary herself that the "Work for Women Fund" was started, to provide employment for as many women as possible who have been thrown out of work. Many are the ways in which the hands of these unfortunate unemployed have been kept busy, assisting in the great work of alleviating the distress of others while helping themselves. Among other schemes is one for utilising the services of women to fill the places of those who were taken away from the land. The following quotation from an article appearing in Woman at Home on "Queen Mary's Work for Women Fund" refers to this phase of the great organisation :—

"Perhaps of all the experiments tried by the Central Committee, the back-to-the-land scheme at Radlett in Herts has given the greatest amount of real pleasure to those who are taking part in it. We have seen in the faces and figures of recruits marching past our windows the transformation of thin, pale, sickly youths used to office work into bronzed creatures with chests to be proud of after a few weeks of open-air life. Something of the same sort has happened in the case of a little group of East-end girls who are hard at work developing an acreage of land with fruit and vegetables and flowers. They are in training as market gardeners, and the Central Committee is for a limited time paying them wages until they shall be ready for work elsewhere. They are between the ages of eighteen and twenty and their comfort and well-being are having careful supervision."

SCHOOLBOYS.

The following extract from a letter regarding the question of boys of school age being used for agricultural work during the mobilization of His Majesty's present forces, is signed by "The Chairman of a School Attendance Committee" and addressed to the Editor of the Spectator :—

The deficiency of men must be made up by women and boys. Old men hardly affect the matter, as rural labourers do not give up work so long as they are fit to do any. Some labour-saving machinery may be installed where farming is conducted on a large scale and there is ample capital, but neither this nor Belgian labour will generally solve the difficulty. Women and boys remain. Let me deal with the women first. On the whole it is a good thing that female agricultural labour has diminished. In the North, where it is still common, it will probably expand this year ; in the Midlands, and where the disappearance of the dairymaid is recent, it will probably revive. In many districts, particularly near London, there remain only the boys to make up the deficiency, and I think that before the hay harvest the demand for boy labour will become irresistible. It will be well that we should consider in time how the most good and the best harm may result. Everybody must lose or go without something on account of the war, and if some boys lose some education, how can the loss be minimised ? First of all, the law should generally stand as it is, enforcing attendance up to fourteen years of age. Probably no one will wish to see the law repealed in this respect, for the exceptional and temporary character of exemption should be kept in prominence. Nor should the laws or by-laws prohibiting the employment of children be set aside : employers would become indiscriminate in engaging boys unless they realised that they may still be liable to prosecution. The

present system of examinations for labour certificates is not very satisfactory, and merely to develop it would not induce satisfaction. My experience of rural schools leads me to think that the safest scheme would be one which may sound cumbersome but would not in practice be so in country districts where "everybody knows everybody." The farmer, knowing of a likely boy whom he wishes to employ, should apply to the parents. The parents, if willing, should apply to the school managers, who, after consulting the teacher, should grant or refuse leave for whole time or half time. They should then inform the school attendance officer of their decision. The local Attendance Committee should delegate their discretion to prosecute or refrain to the managers, even if they demand information and keep some supervision. In support of this scheme I would say that the demand should come from the farmers. It will be the parents' business to see that the boys are not "sweated" either with too heavy work or too long hours or too little pay. Then I would give discretion to the managers. They probably know the farmers, the parents, and the boys, the conditions of the work, the homes and probable prospects of the boys. But I would insist on their taking the teacher into consultation. He should know best which boys would lose least by missing some of their literary education, and which might even be said to be likely gainers by early specialization in the technical education of agriculture.

CASSAVA EXPERIMENTS.

FLAT VS. BANK.

Two plots of cassava were grown with the object of ascertaining, with some degree of accuracy, the weight of green roots produced per acre. Like the arrowroot cultivation, in one section the cassava was grown on the banks (which is the usual estate practice), whilst the other section was "flat." In both cases the cuttings were planted at 5 ft. by 2 ft. The results this season showed an increase of yield of 3,525 lb. per acre in favour of the "flat" cultivation, the yields being at the rate of 17,570 lb. green roots per acre on the "flat" cultivation, and 14,054 lb. on the banked land. The soil in the two plots was, so far as appearances go, of similar fertility, and the plants themselves were ordinary estate cuttings, so that there is every indication that the increased yield may be attributed to the method of cultivation. As, however, one season's results cannot be definitely relied upon, the same point will be tested in next year's experiments.

No selection work has been done with this crop, but it is proposed to make selections from amongst next season's plants.

EXPERIMENTAL SHIPMENTS OF DRIED ROOTS.

In order to test the market in Canada for dried cassava roots, a trial shipment of the article was made to the West India Company, Montreal.

The roots were sun-dried on galvanised wire mesh trays, such as are used in drying arrowroot starch. The average percentage of thoroughly dried roots was 38, although in some cases 40 per cent. was obtained. The product was shipped in ordinary cacao bags.

The calculations given are based upon the results of the trial shipment, together with the trial at the Experiment Station. As will be seen, the dried cassava roots realised $35 per Canadian ton of 2,000 lb. in Montreal. The average estate yield of 10,000 lb. per acre was calculated from information given by a local planter, who cultivates a considerable area of cassava each season.

SUMMARY OF DATA CONCERNING DRIED CASSAVA ROOTS.

Results of trial shipment as per account sales :—

Cr.				$	c.	$ c.
By 11 bags dried cassava roots 1,457 lb. at $35 per ton of 2,000 lb. ex rails, Toronto						25 50
Dr.						
To Customs Entry				1	00	
.. Ocean freight				3	58	
.. Rail freight 1,430 lb. at 38c.				5	43	
.. Commission on $25·50 at 2½ per cent. ...					64	10 65
Balance due ...						14 85

Yields at Experiment Station, 1913 :—

On banks at rate of 14,000 lb. per acre.
„ flat „ „ „ 17,000 „ „ „

17,000 lb. would give at 38 per cent. 6,460 lb. dried roots, or approximately three tons of 2,000 lb. gross value at $35, $105 (£21 17*s.* 6*d.*) per acre. Net value in Kingstown at $21·72, $65·16 (£13 11*s.* 6*d.*) 14,000 lb. would give at 38 per cent. 5,320 lb. dried roots, approximately 2½ tons of 2,000 lb. per acre—gross value, at $35, $87·50 or £16 4*s.* 6*d*, and net value in Kingstown at $21·72, $54·30 (£11 6*s.* 3*d.*) Average yield on estates 10,000 lb. 10,000 lb. would yield at 38 per cent. 38,000 lb. dried roots—gross value $66·50 (£13 17*s.*) Net value at $21·72, $41·26 (£8 11*s.* 11*d.*)

HOW NET VALUE IN KINGSTOWN OF ONE TON WAS ESTIMATED.

Value of one ton of 2,000 lb. in Montreal $35·00 (£7 5*s.* 10*d.*)—

Freight at 54c. per 100 lb....	$10 80		
Customs entry ...	1 00		
Commission at 2½ per cent.	88		
Lighterage, etc. ...	60		
	$13 28	$13 28	(£2 15*s.* 4*d.*)
Net value in Kingstown ...		$21 72	(£4 10*s.* 6*d.*)

COMPARISON OF PRICES OF DRIED CASSAVA ROOTS AND CASSAVA STARCH.

The following figures show that when cassava starch is selling at $6·85 per barrel of 220 lb. in Trinidad, the value is on a par with dried cassava roots at $35 per ton in Montreal. In other words, when cassava starch is selling at over 3c. per lb. in Trinidad, or over 2½c. per lb. in the Colony, it is more profitable to manufacture starch than to sell the dried roots.

In this comparison no allowance has been made either for depreciation of machinery, or the difference in cost of labour in the preparation of the two products. Such allowance would need a more accurate estimate than I feel in a position to give, but would undoubtedly, at least in the matter of machinery, be in favour of the manufacture of the dried roots.

The starch extraction by weight from the green roots is placed at 17 per cent., which is calculated from information given by local starch manufacturers. Details of calculations :—

5,000 lb. green roots yield 2,000 lb. (1 Canadian ton) dried roots or 850 lb. starch.

Therefore, for the selling price to be on a par with dried roots at $35 in Montreal ($21·72 in Kingstown), the starch would realise $6·85 per barrel of 220 lb. in Trinidad ($5·60 per barrel in Kingstown).

The net value of the starch has been calculated from account sales, the charges per barrel, when shipped to Trinidad, being as follows :—

		$ c	$ c.
Cr.			
By 1 barrel of cassava starch ...			6 85
Dr.			
To Freight		24	
,, Export Duty		12	
,, Import Duty		50	
,, Porterage		05	
,, Commission at 5 per cent. ...		34	1 35
Value in Kingstown ...			$5 60

—TRINIDAD AND TOBAGO BULLETIN, XIV, 2.

COMMELINA NUDIFLORA.

Amongst the various problems studied in Hawaii is the production of suitable forage for dairy cows at Glenwood sub-station. The peculiarity of this locality is the heavy rainfall which ranges from 200 to 250 inches per year. The soils are saturated most of the time and most legumes and other forage plants do not thrive.

The Report of the Hawaii Agricultural Experiment Station for 1914 states that, "as a soiling crop *Commelina nudiflora* has come into great prominence. This plant grows wild throughout the Glenwood substation and ratoons readily giving heavy crops in succession particularly if a top-dressing of manure is added from time to time after cutting." * * * *

"It is probable that an extension of the present crude system of live-stock farming with *honohono* (*Commelina nudiflora*) and Para grass as the main crops, could be made very profitable. In the summer months there is much more growth than during winter. *Honohono* lodges badly and Para grass becomes woody if left in the field after a certain stage of development. To prevent loss of the surplus in summer, some means of storing is needed. The soil offers one means of solving this difficulty."

Commelina nudiflora is a very common plant in the moist low-country. TRIMEN states, "In shady places amongst grass in the low-country, very common." It is known as *Girâpala* ('parrot-beak') by the Sinhalese

The plant is nearly glabrous, with a stem 2-3 ft. long, branching from the base. It will be seen from the table of analyses given below that it excels Guinea grass and Water grass, the two feeding stuffs commonly used in Ceylon. Between Rakwana and Bentota the country is suitable for cattle-rearing as there is a plentiful supply of sweet grasses, but the constant and

heavy rainfall causes periodical flooding of the country. This forage plant is worthy of note for this locality.

Kind of feed	Protein	Fat	Nitrogen-free extract	Crude libre	Ash
Guinea grass	5·52	0·87	54·59	28·17	10·89
Water grass	11·23	2·44	42·21	34·48	9·55
Commelina nudiflora	13·27	2·77	47·62	22·24	13·33
Alfalfa	25·26	1·76	32·25	28·85	11·23

TILLERING OF CEREALS.

At a meeting of the Farmers' Club held at the Whitehall Rooms, Hôtel Métropole, S.W., the Rev. E. Seeley, of Tunbridge Wells, read a paper on "The Tillering of Wheat."

Mr. Seeley explained the tillering or stooling habit of cereal plants, and described the conditions that encourage or restrict the process. Wheat and other cereals were capable, under favourable conditions, of developing a number of stems from one root, and although this might be seen demonstrated in any field, there were great differences in the freedom of its operation, both as between individual plants and in different localities.

Mr. Seeley said that liberal tillering was largely the result of opportunity. The plant with a strong root hold and a fair length of stem underground would branch more freely than that which germinated near the surface. One means of promoting free tillering was to plant the seed deeper than usual, but an objection to this was that deep planting was prejudicial to the healthy germination and robust growth of the young plant. Cereals in their early stages of growth must be near sunlight.

The question, therefore, was how to reconcile the conditions that stimulate germination and tillering respectively. He was convinced that the problem could be solved by the use of a machine he had invented, which was undergoing a trial this season on the Corporation Farm, Nottingham, and elsewhere. The principle of the mechanical tillerer was that it pushed the earth close to the roots of the cereals sown in drills, at intervals, as might be required. By this means the development of the stem underground was prolonged and the plant was provided with an opportunity for exercising its clumping or stooling habit, thereby filling the ground in such a way as to effect an appreciable economy in seed and increase the yield of both straw and grain.—The Times.

The so-called briar root from which the cheap and popular pipe of that name is made is really a nodular structure which forms on the root of *Erica arborea*. It was believed that supplies of the root were only obtainable from Austria, but acording to the Kew Bulletin Corsica can supply an unlimited quantity of the commodity.

AGRICULTURAL IMPLEMENTS AND MACHINES.

Circular No. 6 issued by the Department of Agriculture, Mysore State, deals with implements and machines suitable for Indian conditions and is intended to help the agriculturist in the choice of them. Most of these are kept in stock by the Department, which also undertakes to procure any special machine that may be required for abroad and to set it up and give instructions as to its use.

Under the head of ploughs a number of cheap and effective implements are described. The advantages of an improved plough are thus enumerated :—

(1). It does not, like the Country plough, leave any unstirred soil between the furrows; the land can therefore be prepared for the seed after one ploughing. In the case of the Country plough several ploughings and cross ploughings are required before seed can be sown.

(2). It ploughs deeper, whereby the water-holding capacity of the soil is increased and more space is afforded for the penetration of plant roots.

(3). The furrow slice is inverted and pulverised by the mouldboard ; and, as a result, there will be more thorough aeration, and noxious weeds and insects will be exposed and killed.

(4). The furrows are wider, and therefore more land is ploughed up by the improved plough for the same distance covered by the bullocks.

The ploughs described are the "Verity" of Canadian make, "Kolar Mission" (American) and "Eureka" (made by the Kolar Mission). The last mentioned is intended chiefly for small bullock power. It has a single handle and adjustable wooden reversible steel share, and though it does not turn or pulverise the furrow slice as well as the other ploughs named, it is said to be much more efficient than the Country implement. The depth of the furrow is $4\frac{1}{2}$ inches and width 5 in., and with a pair of ordinary bullocks it is possible to work $\frac{1}{2}$ to $\frac{3}{4}$ acre in a day. The price is only Rs. 9 and extra shares cost 50 cents each.

The function of the cultivator is to break up the clods left by the plough and loosen and pulverise the soil : while that of the harrow is to gather up weeds and form a level seed bed. It is pointed out that harrowing and cultivating increase the feeding area of the roots and the capacity of the soil for catching water and holding it : both operations helping to aerate the soil and promote the activity of germ life.

The American disc harrow suitable for a pair of strong bullocks has 6 discs and costs Rs. 100 while a lighter type manufactured by the Kolar Mission suitable for a pair of ordinary bullocks is priced at Rs. 32·50, and the workable area is given as $2\frac{1}{2}$ acres per day.

The six-shovel cultivator, also of local make for stirring the soil to a depth of about 3 inches working with ordinary bullocks, costs only Rs. 12. About 2 acres could be worked in a day.

Among machines the most interesting are those for threshing and winnowing The thresher is suitable for paddy and kurakkan. Four pairs of ordinary bullocks are required for this machine, which can deal with about 20 bushels of paddy and 13 of kurakkan in an hour. The American made machine is priced at Rs. 410 and that made by the Kolar Mission at Rs. 350.

The winnower, which is priced at Rs. 80 and is designed to deal with various kinds of grain, requires one man to work it and another to feed it and remove clean grain. Riddles of galvanised wire for dealing with different grains cost Rs. 3 each.

The Director of Agriculture, Mysore, writing to the Secretary of the Agricultural Society, says :—" We are using bullock power with fourway head pieces to drive the machine, but engine power gives a more steady speed, which is a distinct advantage. Furthermore the working cost would be decidedly cheaper in the long run if the machine is worked by an oil engine. A $3\frac{1}{2}$ H. P. engine is sufficient, but if there is other work to be done a higher power is desirable. The outfit will thresh 400-500 lb. ragi (Kurakkan) per hour and will work normally about 6 hours per day, i. e. from 1 to 7 p.m. the forenoon being devoted to the drying of sheaves in the sun."

AGRICULTURAL PRODUCTS OF PERU.

Cotton is grown throughout the coastal zone. During the past two or three years the area under this crop has considerably extended, and many sugar estates are planting a fair quantity of cotton. The quality also has improved very much owing to the introduction of modern machinery. The coast of Peru is admirably adapted to the growth of cotton, for the mildness of the climate and the absence of storms and heavy rains reduce the work of cultivation ; thus the cost of production is 2 or 3 cents a pound less than in the United States. Besides, the yield per unit of area is greater in Peru than in any other part of the world. Upland cotton (*Gossypium hirsutum*) gives from 553 to 968 lb. per acre in the Cañrnete Valley and a maximum of 1,384 lb. has been reached in the Lambayeque Valley. Sea Island gives an average of 447 lb., Mit Afifi up to 550 lb. on the coast and 830 lb. in the upper valley of the Pativilca. The Peruvian average production is 484·4 lb.; the Egyptian 390·4 lb.; the United States 308 lb. or less.

Sugar cane occupies between 75,000 and 100,000 acres of land. During the past two years, 1912—1913, more than £1,500,000 have been invested in machinery installations. In 1912, 192,754 metric tons of sugar were produced (of which 149,188 metric tons were exported) and over 1,980,000 gallons of alcohol from sugarcane. The 1913 crop was about the same. In Peru the production runs as high as 40 tons per acre, while in Cuba it is approximately 22 tons per acre. Sugar is produced in Peru at a cost of from £5 to £6 per ton, against £14 per ton in Louisiana, £9 in the West Indies and £12 to £14 in Hawaii.

Rubber.—Wild rubber is chiefly obtained from *Hevea brasiliensis* which grows usually to a height of 60 to 70 ft. in the lower lands up to an elevation of 300 ft. *Castilloa* is also found in Peru at higher altitudes and provides the *caucho* of trade. Along the Halluaga river and at other points in the eastern Provinces extensive rubber plantations have been laid out. The rubber output in 1913 was 2,781 metric tons, valued at approximately £816,000. The highest previous production was 3,193 metric tons in 1912, valued at £1,380,000.

Coffee.—Several kinds of coffee are grown in Peru, all being of superior quality; its cultivation has reached the largest development in the Montaña and Sierra districts. Usually 200 trees are planted to the acre and after the third year the yield from each coffee plant is more than one pound in weight.

Vineyards.—Wine growing has been practised for centuries ; of late years the vineyards have extended considerably, especially in the Ica Valley, where they cover about one-fifth of the cultivated area (namely about 8,000 acres) in the Moquegua valley, the vineyards of which are considered to produce the best Peruvian wines, and in the neighbourhood of Lima and Arequipa. In 1907 some experimental vineyards with over 10,000 vines were planted in the Moquegua valleys.

Maize is grown extensively, the maize of Cuzco being considered the most productive as well as the largest and most vigorous of all the known varieties.

Rice is grown chiefly in the Department of Lambayeque and the district of Pacasmayo.

Barley and *wheat* are grown mainly on the upland plateaux. The Peruvian Corporation has been carrying out a successful series of experiments in the vast arid upland Lake Titicaca region with cereals and grasses brought from the high altitudes of China, India, Tibet and Abyssinia and from the dry plains of Persia, Siberia, Smyrna and Tripoli. Experiments are also being made in the Junin highlands with Siberian alfalfa.

Lima beans, native in Peru, grow to perfection and yield an average of 1,700 lb. per acre.

Tobacco has been grown in Peru from remote times. Tumbes, Jaen, Hunacalamba, and Jeveros are the chief sources of the supply of the leaf.

Coca.—The production of coca has decreased considerably in recent years. The largest area devoted to this industry is in Southern Peru around Cuzco. In 1913 7,187 lb. of cocaine worth £28,000 were manufactured.

Tea.—In the vicinity of Cuzco experiments are being made with the production of tea, and leaves of excellent quality have been obtained.

Fruits and Vegetables.—All the fruits of the tropics and of the temperate zone can be grown to perfection in Peru. The olive was imported into Peru during the time of the viceroyalty; it is, however, only within recent years that it has assumed importance, especially in the coast Province of Camaná, Department of Arequipa, and in Ilo and Moquegua. In the latter department are to be found the best varieties introduced from Seville, Spain.

Forests.—Their utilisation, in spite of their wealth, is at present prevented by the transportation problem, but will no doubt be solved in time.

Stock raising.—In Peru the raising of live stock is extensively practised, and especially in the Departments of Cajamarca, Junin, Ayacucho and Puno and in the districts of Acomayo, Chumbivilcas, Canas and Anta. In these districts the estates are large. The Peruvian cattle, which it is believed originate from the stock imported from Spain, are of medium size, strong for work in the field, but rather inferior for beef or dairy purposes. In order to improve the stock several choice breeds have been introduced with success, especially the Shorthorn and Brown Swiss. The exportation of hides and skins and the tanning industry are of growing importance. The goat and kid skins of Piura are in great demand.

The wool product in 1913 amounted to 4,710 metric tons, valued at £649,806. Recently Tierra del Fuego and Patagonian sheep have been introduced for cross breeding. A British enterprise conducts a sheep ranch at Atocsayco, where the yield has been as much as $6\frac{1}{2}$ pounds per head. Besides sheep's wool, Peru produces that of the llama, the alpaca and the vicuna. The female alpacas yield from $5\frac{1}{2}$ to $6\frac{1}{2}$ lb. of wool and the males from $6\frac{1}{2}$ to $8\frac{3}{4}$. Pigs are reared chiefly in the Barranca, Supe, Huacho and Chancay valleys, where they are fattened with maize, lucerne, sweet potatoes and barley. The principal object of breeding pigs is the production of lard, which amounts to over 2,200,000 lb. per annum. This quantity, however, is insufficient to meet local demands.

The following are the most important items of agricultural produce exported during the year 1913 :—

	Metric tons.	£
Cotton	56,162	1,564,844
Sugar	142,902	1,412,665
Rubber	2,781	815,998
Wool	4,711	649,806
Skins and Hides	3,727	200,924
Guano	37,530	150,120
Panama Hats	—	118,735
Rice	3,410	78,226
Cattle	—	39,705

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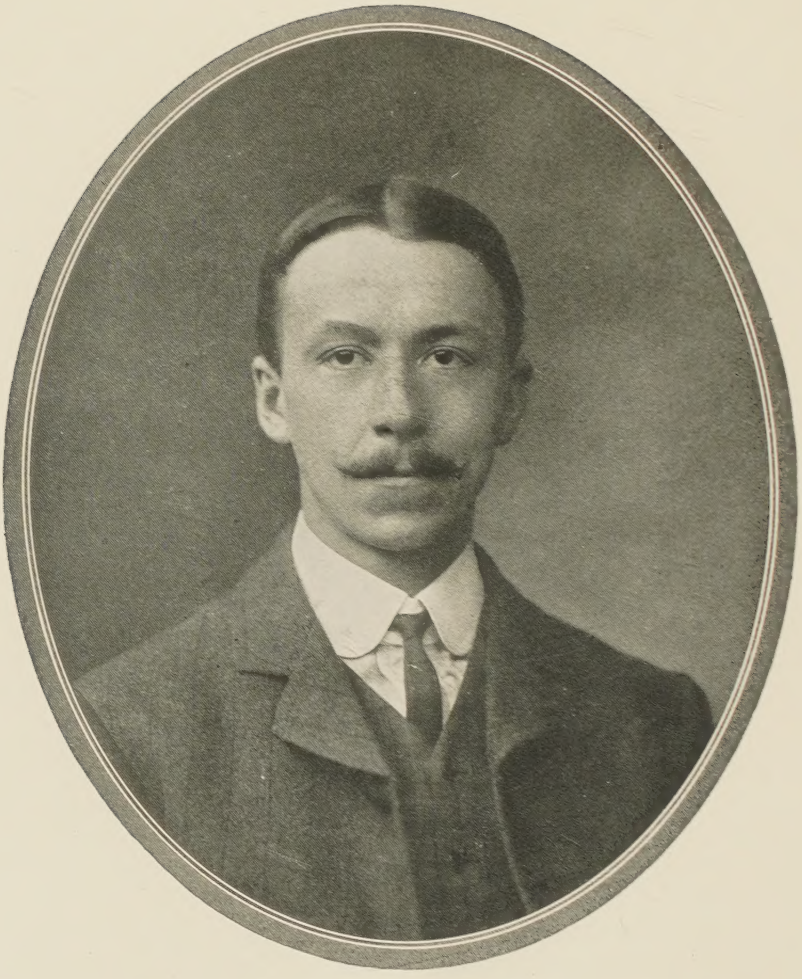

THE LATE DR. R. H. LOCK, M.A., SC. D.

Formerly Assistant Director, Royal Botanic Gardens, Ceylon

THE LATE DR. R. H. LOCK.

We regret to record the death which took place on the 26th June last of DR. R. H. LOCK, M.A., Sc.D., late of the Department of Agriculture, Ceylon, DR. LOCK was the son of Rev. J. B. LOCK, and was born on January 19, 1879, at Eton College where his father was at that time an assistant master. He was educated at Charterhouse and Caius and took First Class in both parts of the Natural Science Tripos. He was Frank Smart Student in 1902. DR. LOCK came out as Scientific Assistant to the Director of the Royal Botanic Gardens, Ceylon, in 1902, and worked with plant-breeding experiments with peas and maize, and provided the first demonstration of MENDEL'S law based on a large number of crosses. He also carried out experiments on the growth of bamboos which provided BLACKMAN with part of the evidence on which the latter based his theory of limiting factors.

He returned from home in 1908 as Assistant Director, and carried out experiments in plant breeding on tobacco. After acting as Director in 1909, he devoted himself more to the agricultural side, and instituted experiments in selection of paddy and also began experiments with arecanuts. He proceeded home on 3 months half pay leave in 1910, and on his return acted again, a year later, as Director.

As a result of his investigations of the cocoa experiments on Gangaroowa, he was led to question the efficacy of the manures applied in that particular case, and advocated the cessation of manuring for some time—a course which appears to have been justified by the results.

In 1912, DR. LOCK initiated a series of tapping experiments at Gangaroowa which, with the exception of the previous experiment instituted by himself and MR. BAMBER at Heneratgoda, are the first in Ceylon to be conducted on a rigorous experimental basis.

DR. LOCK went home having resigned his appointment on November 20, 1912, and was appointed an Inspector under the Board of Agriculture and Fisheries, London, in the following year. During his stay in Ceylon DR. LOCK identified himself with sport and was a member of the Ceylon Mounted Rifles. He played tennis, cricket, and golf, and won the Clifford Cup (Golf) at Peradeniya in 1912. We express our deep sympathy with his widow and bereaved relatives.